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PERCEPTIONS OF ENVIRONMENTAL CHANGE: NIKUTORU, TABITEUEA MAIAKI, KIRIBATI

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The comparisons of scientific measurements taken around the world show trends of climate change, which are affecting the traditions of vulnerable populations. In the Pacific, many island peoples are already feeling the effects of the changes and are facing the predictions of future impacts. Some nations, like the Republic of Kiribati, are addressing the present and projected problems with proactive policies, while engaging with international agencies and cooperating with citizens in order to develop appropriate approaches to the change. The contribution of local knowledge has been recognized as valuable in assessing the changes and in the development of response strategies. This research accesses the traditional ecological knowledge of an outer island community in Kiribati in order to identify the presence or absence of change in their environmental resources. Through the analysis of the responses gathered regarding the perceived past and present qualities of the environmental resources on their island, changes were identified. The effects of those changes were recorded along with the reactions to the changes in the qualities of the environmental resources. The information gathered in this case-study complements the scientific measurements and predictions, showing consistent reports of higher temperatures, rising sea-levels, and seasonal irregularities, while supplementing the current body of literature with site-specific data, contributing local-level observations to a global phenomenon.

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Chapter 1
Introduction

Various effects of climate change are impacting the traditional subsistence lifestyles of the people on the Pacific Islands. Scientific measurements have been made, through reconstructed records and modern techniques, of temperatures, shorelines, and seasonal variation. The comparisons of these data sets conclusively conclude climatic changes of higher global temperatures, rising sea levels, and changing seasonal patterns while the scientific evidence suggests a strong likelihood that the changes will continue.

Those people most at risk from the effects of environmental disruptions are already feeling the effects of climate change impacts on low-lying islands in the Pacific. The populations considered most vulnerable are those identified as Small Island Developing States (SIDS), because of their susceptibility to environmental hazards, and as Least Developed Countries (LDC), which have limited adaptive capacities due to their low level of socio-economic development. The inhabitants of these islands, such as those in Kiribati, are already reporting experiences of warmer temperatures, rising sea levels, seasonal irregularities, and other perceptible ecological alterations. The vulnerability of populations in Small Island States and Least Developed Countries is increasing as the effects of climate change impact their local island environments.

The traditions of vulnerable island populations are also affected by the changes. The lifestyles based on subsistence methods were established with the traditional ecological knowledge (TEK) that was acquired through generations of island inhabitation. The practices and customs that sustained the people in the past have continued into the present but are increasingly vulnerable to rapid environmental

changes. Although islanders had been able to adapt to environmental variations in the past, some populations are finding their efforts ineffective against the current challenges of climate changes as the traditions that had previously sustained island subsistence are threatened.

The Republic of Kiribati, straddling the equator and the International Dateline in the Central Pacific, is considered, on the Environmental Vulnerability Index, to be "extremely vulnerable" to these present and projected environmental changes (SOPAC 2005). The country encompasses three island chains, the Gilbert Islands to the west, the central Phoenix Islands, and the Line Islands to the east, with a total of 33 islands, all but one (Banaba) are low-lying coral atolls with limited natural resources. The people of Kiribati have inhabited the islands for many generations and continue to rely upon the traditional ecological knowledge gained throughout their years of experience. As the area is affected by environmental changes and the effects on their traditional subsistence systems impact the people, the islands of Kiribati serve as a suitable site to gather small-scale specific data about the changes occurring. Local-level observations can provide a complementary spatial and temporal scale of details that contribute to the body of knowledge about the global phenomena of climatic change.

The living conditions on the islands of Kiribati are influenced by developmental and environmental problems. Considering the specific predictions for the islands of Kiribati, future struggles from the impacts of climate change are accepted as an inevitable reality. The government of Kiribati has decided to take a proactive role in addressing the impacts of climate change and has put in place policies that tackle immediate and imminent needs of its citizens on the islands. Through the focused efforts of short-term

Figure 1.1 Regional map of Oceania. Source: CIA World Factbook

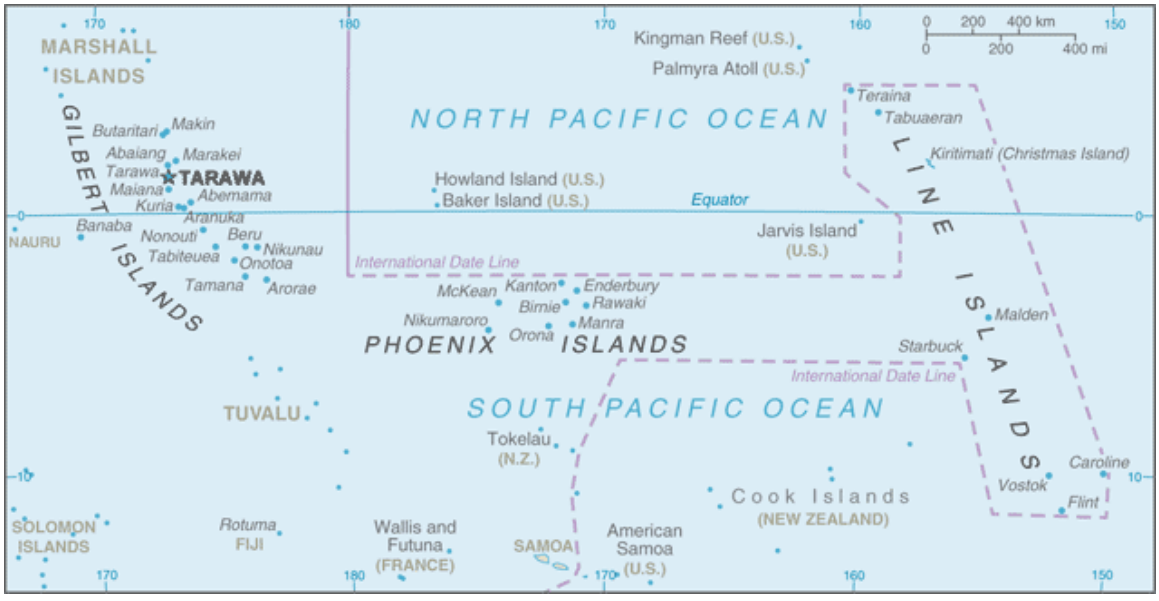

Figure 1.2 Regional map of the Republic of Kiribati, including the Gilbert, Phoenix, and Line Island chains. Source: CIA World Factbook

and long-term planning, the government of Kiribati is setting an example of how adaptation measures can be applied to address local issues, while continuing to monitor the levels of sustainability on the islands. The changes brought on by climate change have forced the people of Kiribati to consider future scenarios beyond the shores of their native lands. In the event that the islands become uninhabitable, the country of Kiribati is training its population as a viable work force, capable of emigrating and adjusting as citizens in foreign countries. The government is working to provide a place for the relocation of its people if a mass migration becomes necessary. As the country faces changes to its sovereign lands, it is attempting to prevent the many problems that arise with the displacement of a population.

In addition to the domestic efforts of island nations in the Pacific, there is also international participation in programs focused on environmental change in the area. Interested parties include intergovernmental organizations and regional cooperatives. Collaboration is occurring on multiple levels, as community members are included in the planning process. The contribution of traditional ecological knowledge, by citizens, is beginning to be recognized as a valuable asset when applied to environmental resource management and in response to local and regional changes.

The changes occurring on a global scale are known on a local level as communities are exposed to the reports and explanations presented through various formats. The personal responses to the predictions range, as do the physical reactions to the perceived changes, of which few have been documented. In order to facilitate locally appropriate aid for affected peoples, information is needed regarding the realities faced by local communities impacted by environmental changes. Through public awareness of

the current and future situations, traditional knowledge and skills can be applied to the development of culturally appropriate strategies for addressing local environmental changes.

This research contributes local-level observations of environmental change to the global aggregate of information. Since there is a limited amount of previously recorded data for the region, an outer island in the country of Kiribati was used as a case study to exemplify the conditions found on atolls in the equatorial Pacific. Local perceptions of the past and present qualities of environmental resources on the island were used to identify changes in the resources, effects of those changes, and local reactions to those effects. This information, collected through participant observation, interviews and participatory mapping, and analyzed both quantitatively and qualitatively, was found to be consistent with the trends and predictions for the region and can inform policy makers in their efforts to respond to the needs of local communities affected by environmental change.

Chapter 2 begins with a general overview of the causes and measurements taken of global climate changes that have occurred in the past and up to the present. The chapter introduces the impacts of contemporary climatic changes on Pacific island environments and the effects of those changes on island inhabitants. The islands of Kiribati are introduced in this section as a case study for studying environmental changes on islands in the Pacific, due to its vulnerability and dependence upon traditional ecological knowledge.

Chapter 3 provides a thorough review of the research project conducted for this dissertation. In this chapter, the research question is proposed and the objectives of the

project are outlined. The theoretical foundation of the dissertation is laid out in this chapter along with the qualitative and quantitative methods used to conduct fieldwork. Techniques used for data analysis are also explained and justified in this section.

Chapter 4 presents the responses collected in the field and the results of analysis. The responses regarding past and present qualities are quantitatively presented in tables according to their resource categories and then descriptively listed to identify changes in environmental resources. The changes identified are described in qualitative terms, as are the effects of the changes in the qualities of environmental resources and the reactions to the effects and changes.

Chapter 5 provides an overview of the efforts made on national and international levels to address the current and future effects of environmental change on the islands of Kiribati. The stance of inevitability taken by the government of Kiribati and the proactive policies enacted to address the challenges of environmental change are reviewed. The collaborative partnerships developed on the local and global levels are also described in this section.

The final section**,** Chapter 6**,** proposes the significance of this work and its broader impact of filling a lacuna in local literature and of contributing to a larger body of regional and global knowledge. Chapter 6 states that useful comparisons can be made between the global measurements and regional predictions with the local perceptions and reactions reported by the island informants, and draws the conclusion that consistencies can be found between the two scales.

Chapter 2
Climate Change in the Pacific: A Kiribati Case Study

2.1 Climate Change: A General Overview

Climate change can be caused by a number of variables. Scientific measurements of these different variables are used to compare past and present climate records and to predict future trends. Records, reconstructed from evidence of past climate cycles, have been used for comparison with modern measurements taken of temperatures, shorelines, and seasonal patterns are used to identify signs of climate change or consistency. The results of these assessments conclude changes in trends, such as higher global temperatures, rising sea levels, and changing seasonal patterns. And while there may be limitations when making projections, there are predictions that indicate potential problems for vulnerable populations.

2.1.1 Measurements of Environmental Elements

Climate change is an incremental environmental change that occurs from natural and/or anthropogenic causes. Variability may be a result of natural internal processes within the climate system (internal variability), or of variations in natural or anthropogenic external forcing (external variability) (Mastrandrea and Schneider 2010:14-23). While natural internal and external forcings continuously influence climate, there is compelling scientific evidence that human activity has significantly altered the climate system (Mastrandrea and Schneider 2010:22; Maurits la Riviere 1990; Meehl et al. 2007; Santer and Wigley 2011; Stern 2009). The Earth's climate is in a constant state of fluctuation due to these internal and external causes and the effects of these variables

are being recorded and compared in order to identify patterns in past and present measurements.

Records of past climates have been created through the compilation of evidence: biological (tree rings, pollen, corals, and fossils), cryological (ice cores), geological (rock, sand dunes, ocean sediment, glacial debris, and stalagmites), and historical sources (written records and oral histories) (Henson 2011; Mastrandrea and Schneider 2010; Santer and Wigley 2010).

Substantial developments have occurred in contemporary measurement techniques. These innovations have improved understanding of data issues and uncertainties and allow for better quantification of regional changes. Diverse methods are used to determine land-surface air temperature (LSAT) and sea surface temperature (SST). *In-situ*, site-based, measurements are taken along with remote satellite observations. Historically, most SSTs were obtained from moving ships and buoy measurements and these measurements still comprise a significant fraction of *in situ* SST measurements; now satellites also provide SST data sets although they are generally less accurate despite their better global coverage than *in situ* measurements (Curran 2002:xii; Emery et al. 2001; Hartman et al. 2013:190-191).

Measurement of sea level is the longest-running ocean observation system and has evolved over time. Sea level varies, on time scales and spatial scales, as the ocean warms and cools, as water is transferred between the ocean and continents and between the ocean and ice sheets, and as water is redistributed within the oceans due to the tides and changes in the oceanic and atmospheric circulation. Measurements have been recorded in Northern Europe since the 1700s and by the early 1900s tide gauges had been

placed around the world although most were not suitable for climate studies until the 1970s (Douglas 2001; Emery 1980; Hartman et al. 2013:285). Although satellite radar altimeters made the first nearly global observations of sea level in the 1970s and 1980s, these early measurements remained highly uncertain. It was only since 1993 that large-scale spatial patterns of sea level change have been known to a high degree of precision (Hartman et al. 2013:288; Nerem et al. 2010).

Although pre-existing data sets have been updated and new measurement techniques developed, they are generally inconclusive because of data limitations and inconsistencies due, in part, to the use of different types of measurements and incomplete global records, which can affect data availability, quality, and consistency (Curran 2002:xii-xiii; Hartman et al. 2013:216, Pirazzoli 1993). Some variables are particularly sensitive to changing measurement practices, while reporting protocol can affect data quality. Global records are incomplete due to different numbers of recording stations within each region, often leading to the use of proxies (Hartman et al. 2013:209-216; Slagen et al. 2014).

In summary, modern measurement techniques have contributed significantly to the understanding of global climatic changes. Gathering information on atmospheric, land, and sea surface temperatures has grown more elaborate than just the use of *in situ* stations with the implementation of remote satellites. The use of advanced strategies helps interpret the dynamic signals of multiple variables involved in monitoring shorelines, and, although the records are incomplete, contemporary approaches to the use of different types of measurements and approximations provide needed information about extreme weather events and storm tracking. Together this compiled data serves as a

baseline for comparison with past climate models, which, through analysis, provides a snapshot of possible climatic changes.

2.1.2 Comparisons of Components Conclude Change

With past and present climate records, comparisons can be made to identify climate trends. Compiled evidence from numerous sources point to changes in many aspects of Earth's climate including changes in temperatures, sea levels, and seasonal patterns.

Reports show consistent warming trends in global mean air, ocean, and surface temperatures (Abramovitz 2001; Bindoff et al. 2007; Dunn 2001; Meehl et al. 2007; Kelman et al. 2011:28; Mastrandrea and Schneider 2010:12; Mitchell et al. 2001; Santer and Wigley 2010:37; Trenberth et al. 2007). Evidence for a warming world comes from multiple independent climate indicators, which, individually, might be unconvincing but analysis of these different data sets has led many independent research groups to reach the conclusion that the world has warmed since the nineteenth century (Hartman et al. 2013:198-199).

Aggregated measurements show that average global sea level rose over the twentieth century (Abramovitz 2001; Bindoff et al. 2007; Dunn 2001; Meehl et al. 2007; Kelman et al. 2011:28; Mastrandrea and Schneider 2010:12; Mitchell et al. 2001; Santer and Wigley 2010:37; Trenberth et al. 2007). Data also shows a persistent pattern of sea level change in the Pacific since the early 1990's, and while records indicate significant multi-decadal variations in regional sea level, it is not certain as to whether the change is reflective of decadal variability or another trend (Hartman et al. 2013:288-289).

Comprehensive assessments of observed changes in extreme weather events report more frequent storms of higher intensity (Hartman et al. 2013:209, Lubchenco and Karl 2012; Stott et al. 2016). There is evidence of statistically significant changes in average precipitation levels, a mix of positive and negative trends, causing flooding in some areas while affecting others with drought (Hartman et al. 2013:201; Henson 2011:141-161; Huang et al. 2013; O'Gorman 2015; Trenberth 2011). Range shifts and changes in phenology of seasonal timings have also been reported (Berkes 2012:32; Brown et al. 2016; Colautti, Agren and Anderson 2016; Craighead 1994; Henson 2011:162-186; Root and Goldsmith 2011:45-47).

In summary, the compilation of climate data shows general trends that are under constant analysis in order to gain a better understanding and more certainty. Records, constructed from evidence of the past, and modern measurements, which continue to advance, are used to compare the temperatures, shorelines, and extreme events of previous climates with current conditions. Calculations, based on these comparisons, expose changes and show trends of higher global temperatures, rising sea level, and disrupted seasonal patterns, which are predicted to continue.

2.1.3 Projections and Predictions of Future Conditions

There are uncertainties in projecting future climate trends. Even the best global climate models are limited and there are significant uncertainties in estimating the size and geographical distribution of the projected changes to occur during the twenty-first century (Collins et al. 2013:1035-1040; Henson 2011:197; Mastrandrea and Schneider 2010:26; Santer and Wigley 2010:37). Despite their different strategies, various climate

models all predict higher temperatures, rising sea level, and seasonal irregularities. All global regions are expected to experience average air, ocean, and surface temperature increases by 2100 (Collins et al. 2013:1054-1098; Henson 2011:51-64; Meehl et al. 2007; Kelman et al. 2011:28; UNDPPC N.d.). Despite the uncertainties in projecting impacts of climate change, the expected global sea-level rise is amongst the most certain (Barnett and Adger 2003:2; Collins et al. 2013:1093-1095; Henson 2011:116-140; Meehl et al. 2007; Rudiak-Gould 2010:83). Projections point toward future seasonal irregularities, with storm tracks changing, an increased frequency of storms, and a dramatic rise in extreme weather events, such as heat waves, floods, windstorms, and droughts (Collins et al. 2013:1071-1073; Ebi 2011:124; Knutson et al. 2010).

Predictions are inexact regarding changes in annual precipitation, with models projecting a reduction in average rainfall in some areas, while others can expect an increase in overall rainfall (Burns 2000; Collins et al. 2013:1074-1086; Henson 2011:65-81; Kelman et al. 2011:29; Knutson et al. 2010; World Bank 2000). In addition to these predictions, as climate variability increases and shifts geographically, the changes are expected to set off a chain-reaction of impacts within regional ecosystems (Barnett and Adger 2003; Collins et al. 2013:1096-1098; Henson 2011:82-115; Jamieson 2009; Kelman et al. 2011; Rudiak-Gould 2010). Despite projection limitations, some variables can be predicted with high levels of certainty, and when past and present records are compared and trends are extrapolated into the future, higher temperatures, rising sea level, and seasonal irregularities are considered to be realistic possibilities in the changing climate.

As stated earlier, climate change can occur from natural and anthropogenic causes. In order to assess the rates of change, comparisons have been made between constructed records of the past with modern measurements. Despite incomplete global records for climate variables, analyses show that global temperatures are higher, sea level has risen, and seasonal patterns have changed. Taking into consideration the potential limitations inherent in making projections, problems have been predicted with a high degree of certainty, such as higher temperatures, rising sea level, and seasonal irregularities. These changes can have environmental and social impacts on vulnerable populations dependent upon the resources affected by variations in the global climate system on local ecosystems.

2.2 Impacts of Environmental Change on Pacific Island Populations

Although the effects of climate change are global, some populations are more vulnerable to the growing impacts. Small Island Developing States (SIDS) are more susceptible to environmental variations within their island habitats, while Least Developed Countries (LDC) are considered vulnerable because of their limited adaptive capacity. Some of these nation-state populations are already feeling the effects of higher temperatures, rising sea levels, irregular seasonal patterns and other peculiarities brought on by climate change. For many vulnerable populations, especially on small islands in the Pacific, changes in their environment directly affect the traditions and challenge the traditional ecological knowledge that they rely upon for the maintenance of their subsistence lifestyles.

2.2.1 Vulnerability to Climate Change in the Pacific

The most vulnerable to the effects of climate change include settlements in coastal and low-lying areas, and populations highly dependent on natural resources. Small Island Developing States (SIDS) and Least Developed Countries (LDCs), as stated earlier, are amongst the nation-states identified as most vulnerable to climatic changes due to their physical susceptibility and limited adaptive capacity.

Many Small Island Developing States are dependent upon limited local environmental resources, which are often already threatened by growing human pressures (Cocklin 1999; Meehl et al. 2007; Kelman et al. 2011). The effects of expected sea level rise is potentially devastating, especially to low-lying islands and coastlines, and will pose challenges and risks to vulnerable populations (Barnett and Adger 2003:2; Meehl et al. 2007; Nurse et al. 2001; Rudiak-Gould 2010:83).

There are several constraints to adaptation that are inherent in many small islands, including small size, limited natural resources, and relative isolation (Meehl et al. 2007:16.5.4). Vulnerability to climate change will vary according to local climatic effects along with human, institutional, social, and economic adaptive capacity (Ebi 2011:127-128). The main determinants of a country's adaptive capacity to climate change are economic wealth, technology, information and skills, infrastructure, institutions, and equity (Voigt-Graf 2003; WHO 2003b). Many of the populations at risk do not have the resources necessary for adaptation to climate change, such as Least Developed Countries, which are more vulnerable due to their limited adaptive capacities (Meehl et al. 2007:16.5.4; Nurse et al. 2001; Oliver-Smith 2009; Sagar and Baer 2010; Sathaye 2010:271).

In summary, many populations will be impacted by changes in climate variables, but their vulnerability will depend upon how the changes affect the regional environment and their adaptive capacities. Of the vulnerable populations, Small Island Developing States are highly susceptible to the effects of climate change due to their environmental constraints, while Least Developed Countries face the challenge of adapting from a position of limited capacity.

2.2.2 Reported Effects of Change on Island Environments

Environmental changes, consistent with climate change predictions, are already a reality for many inhabitants of small islands across the Pacific. Local populations are recognizing the effects of climate change, rising temperatures, elevated sea levels, irregular seasonal patterns, and other climatic events, on their lifeways (Connell 2003; Kelman et al. 2011; Meehl et al. 2007; Republic of Kiribati 2007:5; Rudiak-Gould 2010:71).

Islands in the Pacific are reportedly warmer under increasingly intense sunlight, which has also resulted in coral bleaching, affecting the health of the reefs (Henson 2011:137-140; Republic of Kiribati 2007:13). The health of the reef affects the shoreline and some islanders have experienced the effects of coastal inundation. Despite some signs of accretion, observations of fallen trees, exposed roots, disturbed burial sites, and receding shorelines are all evidence of erosion (Maurits la Riviere 1990; Meehl et al. 2007; Nicholls 2004; Republic of Kiribati 2007:13; Rudiak-Gould 2010; UNDPPC 2012).

Residential areas have been flooded with seawater and, while traditional housing designs have provided some resilience, persistent inundation already has forced some inhabitants to relocate (Meehl et al. 2007; Republic of Kiribati 2007:12; Schneider 1990; UNDPPC 2012). Meanwhile, storm surges have contaminated fresh water tables with incoming seawater and the resulting salinization has made wells brackish and destroyed crops (Ebi et al. 2006; Ebi 2011; Hales et al. 1999; Harvell et al. 2002; Kelman et al. 2011; Meehl et al. 2007; Republic of Kiribati 2007:iii; UNDCCP 2012). Water resources on small islands are extremely vulnerable to variations in climate and many regions are experiencing irregular precipitation patterns (Nurse et al. 2001; Meehl et al. 2007; United Nations 2011).

Scientific reports provide some articulation of the environmental changes occurring but it is the daily experiences of the island inhabitants that is the real measurement of higher temperatures, rising sea level, and seasonal irregularities. The impacts of these changes are affecting the traditional systems of resource management that are relied upon by some of the most vulnerable populations.

2.2.3 Traditions Affected by Changes

Because of their heavy reliance on local environmental resources, the subsistence livelihoods of people living on Pacific islands are vulnerable to the effects of climate change. The native islanders learned from experience to create methods of sustainable subsistence within their limited environment. The island inhabitants established traditional ecological knowledge of subsistence methods and customs that continued through the generations and into the present day. Now many of those socio-cultural

traditions are threatened by environmental change as island inhabitants find that the strategies they used in the past are ineffective for addressing the challenges of climate change and may not be enough to sustain them if the predicted changes occur. Some island assets, including traditional ecological knowledge, are considered vulnerable and at risk from climate change (Nurse et al. 2001). On small islands, even minor alterations are noticeable and inhabitants who have used their traditional ecological knowledge for adaptation in the past are finding their present efforts ineffective (McIntosh et al. 2000:17; Rudiak-Gould 2010:74).

Since their settlement, populations on many small islands throughout the Pacific have developed subsistence lifestyles adapted to the resources available in their natural environment and they have established the ecological knowledge necessary to sustain their populations within those environmental limitations (Berkes and Jolly 2001; Fox 2003; Meehl et al. 2007; Sutherland et al. 2005). The traditional ecological knowledge (TEK) has been passed on through the generations of inhabitants, enriched over the ages through direct experience, and continues today as the customs of the contemporary island societies (Barnett and Campbell 2010:39; Berkes 2012; Davidson-Hunt and Berkes 2003; Dove 2001; Ellen and Harris 2000; Freeman 1993a; Hunn and Selam 1990; Rose 2005; Townsend 2000). Throughout the generations, the island inhabitants have created and perpetuated systems of resource management, which help their culture to persist. Despite limited land area, many communities on small islands in the Pacific still have livelihoods today, for both subsistence and income, founded on traditional knowledge of their island environments and dependent upon their immediate environment for necessary resources (Berkes and Jolly, 2001; Browne 1989; Fox, 2003; Kelman et al. 2011; Meehl et al. 2007;

Rudiak-Gould 2010; Sutherland et al. 2005). The continuous occupation of their environment has contributed to the knowledge gained through generational experiences and transmitted through personal learning and oral histories, allowing for the creation of the customs that continue their culture.

Many small island societies, historically, have proven resilient to social and environmental upheavals. Island inhabitants have adapted to variability in climate and sea conditions and to extreme events over a long period of time. In Polynesia, Melanesia, and Micronesia, the socio-ecological systems have historically been able to adapt to environmental change (Barnett 2001; Berkes and Jolly 2001; Kelman et al. 2011:28; Meehl et al. 2007:16.5.4). Islanders still carry cultural memories of environmental changes and tell stories of storms washing away entire islands, and of experiencing periodic food shortages, famines, and droughts (Bridges and McClatchey 2009; Nunn 2009:130-181; Rudiak-Gould 2010:75).

Under the current conditions of rapid climate variability and the increase of associated adverse effects, traditional coping strategies and adaptation practices are proving less effective. Risk reduction on Small Island Developing States is frequently based on traditional ecological knowledge but confronted with the changing conditions, that knowledge will need to be adjusted (Kelman et al. 2011:30; Knutson et al. 2010; Republic of Kiribati 2007:11). Traditional management systems are often overtaken by events and in many cases the imposition of foreign concepts has greatly influenced the highly adaptive and flexible systems (Crocombe 1987). There is evidence of the reemergence of some practices, with each generation combining the wisdom of the past with the realities experienced in the present, driving the evolution of traditional

knowledge (Berkes 2012:27; Fox 2003; Goodenough 1963; Ingold 2000; Johannes 1978; Johannes 2002; Meehl et al. 2007; MESD 1999).

In summary, the continuation of some traditions relied upon by islanders are threatened by environmental changes. While people have responded in the past with adaptations, contemporary inhabitants are finding their traditional methods inadequate to address the challenges of the present. The established customs that had successfully adapted to previous challenges are found to be ineffective against the current impacts of climate change.

In conclusion, the vulnerable populations on the islands impacted by climate change are feeling the effects in their local environments. The susceptibility of Small Island Developing States (SIDS) and the limited capacities of Least Developed Countries (LDC) make the inhabitant populations vulnerable to the continued effects of the impacts they are already experiencing in the form of higher temperatures, rising sea levels, irregular seasonal patterns, and other odd observations. The impacts felt by the vulnerable populations are the beginning signs of the effects expected with climate change on the islands. The traditions that have sustained local subsistence are being affected by the impacts of climate change and are being threatened by the current trends of change. The traditional ecological knowledge that was established by the inhabitants has continued to sustain the island populations but the customs that have been retained are under threat from climate change. The adaptive efforts made in the past are not serving as effectively against the present challenges. Despite generations of knowledge, traditional methods are unable to sustain the present populations against the effects of

climate change. The effects of the changing climate trends are impacting the sustainable traditions of the people who inhabit the islands of the Pacific.

Chapter 3
Research Project

3.1 Research Question

Aggregated global measurements show regional trends of environmental change in the Pacific but the generalizations are based on sources with limited local-level information. The people of Kiribati are amongst the most vulnerable to the effects of predicted changes, and while scientific measurements have been taken in some places around the world, there is little data on the qualities of the environmental resources on the islands of Kiribati. The native inhabitants have acquired a traditional ecological knowledge (TEK) of their island environment that can provide the local-level observations necessary to supplement global research. The traditional ecological knowledge held by the inhabitants provides an opportunity to identify the perceived qualities of environmental resources in the past and the present, and to describe any local effects and reactions to the changes of environmental resources.

This project uses the local perspective of native informants, based on their traditional ecological knowledge of the environment, to answer five research questions. The first two questions examine the past and present qualities of the environmental resources on the island. The third question identifies whether there is a presence or absence of change in the qualities of those environmental resources. The fourth question investigates any effects of the changes in the qualities of those environmental resources, while the fifth explores any reactions to the effects of the changes in the qualities of those environmental resources on the island.

3.2 Research Objectives

The research objectives are to describe the past and present qualities of the environmental resources, to identify and describe any change in the qualities, to identify and describe any effects of the changes, and to identify and describe any reactions to the changes or effects. This project uses the perceptions and reactions of local inhabitants to identify information on the past and present qualities of environmental resources, changes in those resources, effects of those changes, and reactions to those effects. This research identifies the changes in environmental resources as perceived by native inhabitants with traditional ecological knowledge and their reactions to the changes in order to make local level information available to a broader audience.

3.3 Theoretical Framework

Two paradigms within environmental anthropology that are useful for understanding the relationships between culture and nature are historical ecology and traditional ecological knowledge (TEK). Understanding environmental change over time is needed in order to assess the current condition of the landscape and to understanding how and why ecosystems have evolved to their current states. The theoretical framework of historical ecology provides a historic dimension to the study of anthropology and the environment based upon three premises: that human beings are part of the ecosystem; that there is dynamic interplay of natural and cultural processes over time; and, that historical ecology is rooted in place to specific geographical locations (Winthrop 2001:206).

The development of traditional ecological knowledge (TEK) results from the experiences acquired over thousands of years of direct human contact with the environment (Berkes 2012:2). Traditional ecological knowledge is dynamic in nature, building on experience and adapting to changes, and is an attribute of societies with continuous use of resources within a particular environment (Berkes 2012:7). Associations often exist between local communities and their physical environments and knowledge of the environment is acquired through this association (Dove 2001:99). Berkes defines TEK as "a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and their environment." (Berkes 2012:7) Traditional ecological knowledge includes local knowledge and ethno-classification systems, culturally-rooted environmental practices and management systems, social institutions, and ideological worldviews that constitute the ethical basis of these systems (Berkes 2012:31;).

Historical ecology builds upon the ecological view of human society as part of the ecosystem, and upon cultural ecology's premise that culture adapts to its biophysical environment (Berkes 2012:2; Townsend 2000:15). Human beings must obtain their material needs from the natural environment and the economy of any society is the way it meets those material needs. Thus, the economy of any society *always* defines an important aspect of human relationship with the environment (Winthrop 2001:206).

A culture is, to a great extent, conditioned by what it has been, making it nearly impossible to fully understand the present without reference to the past (Crane and Angrosino 1992:98). Local environments have social histories and the current

environmental condition represents the historical interaction of humans with their environment (Dove 2001:99). Traditions are not an inflexible adherence to the past. New ideas and techniques may be incorporated into traditions, thus creating enduring adaptations produced over many generations in specific places (Berkes 2012:3-4, 18-19; Hunn 1993:13). Battiste and Henderson (2000:46) explain that what is traditional about traditional ecological knowledge is not its antiquity, but the way it is acquired and used. Traditional knowledge and management systems are not frozen in time, but are adaptive responses that have evolved over time (Berkes 2012:30).

The identity of Indigenous peoples is inextricably linked with their lands, so that ecological aspects of tradition cannot be separated from the social and spiritual (Raygorodetsky 2011). Knowledge is a situated process tied to a specific place and there is always a risk of abstracting traditional knowledge from its cultural and historical context (Berkes 2012:5). Knowledge of the biophysical environment is embedded in the social environment, while, Butz (1996:52) notes, traditional ecological knowledge is symbolically and instrumentally embedded in the places in which they developed and they help constitute (Berkes 2012:6, 31). The landscape is a reservoir of ecological knowledge and a repository for the memory of past events (Berkes 2012:6; Brosius 2001:148). Stories and legends are part of traditional ecological knowledge because they signify meanings and values rooted in the land (Berkes 2012:6; Schensul 1999b:71-72).

A practical understanding of the environment based on traditional ecological knowledge is local, specific, and derived from centuries of experience living closely with the land (Winthrop 2001:209). Constant engagement with the land leads to learning,

whereby knowledge emerges from the long-term relationship between people and place (Davidson-Hunt and Berkes 2003, 2010).

The use of traditional ecological knowledge transfers to succeeding generations the knowledge, values, and identity of the group (Berkes 2012:32; Ellen and Harris 2000; Freeman 1993a; Hunn and Selam 1990; Rose 2005). Heritage is the act of passing on knowledge in the culturally correct or appropriate contexts and times and the use of sites to impart knowledge make them heritage (Smith 2006:46). Heritage is a cultural process that engages with acts of remembering that work to create ways to understand and engage with the present with the sites as cultural tools that facilitate the process of passing on established values and meanings, while creating new values and meanings (Smith 2006:48). Folk art is a heritage medium for learning and transmitting cultural information resulting from both interpersonal relationships and relationships between people and their environment (Crane and Angrosino 1992:111).

Indigenous societies possess vast knowledge of their environments and some studies show that local conceptions of ecological systems rival modern scientific concepts (Dove 2001:99; Healey, 1993; Pernetta and Hill, 1984; Thomas 2001:415). Ethnoscience, or folkscience, as defined by Hardesty (1977:291) studies systems of knowledge developed by a given culture to classify the objects, activities, and events in the universe. Indigenous knowledge systems are often characterized by embeddedness of knowledge in the local cultural milieu; boundedness of local knowledge in space and time; the importance of community; lack of separation between nature and culture, and between subject and object; commitment or attachment to the local environment; and a non-instrumental approach to nature (Berkes 2012:10-11). TEK is limited to more

explicitly land-related knowledge and is considered a subset of the broader category of indigenous knowledge (Berkes 2012:9).

This research builds on existing scholarship that recognizes the value of traditional ecological knowledge and its application in the assessment of environmental resources. There has been an increased recognition of the value of traditional ecological knowledge (Berkes 2012; Crocombe 1989; Johannes 1989; Thomas 2001:416). In the Solomon Islands, for example, it has been demonstrated that traditional ecological knowledge can be successfully integrated with modern conservation efforts (Aswani and Hamilton 2004). Local level knowledge of the environment can provide key information for the understanding and monitoring of regional and global environmental change (Berkes 2012; Capistrano et al. 2005; Eamer 2006; Gadgil et al. 2000; Kofinas et al. 2002; Raygorodetsky 2011; Reid and Vogel 2006). In the context of adaptation to climate change, traditional ecological knowledge can provide a foundation for adaptation and management on the local, regional, and global levels (Fox 2003; Meehl et al. 2007; MESD 1999, Raygorodetsky 2011). Hoffmann (2002) describes the implementation of traditional marine social institutions, one form of traditional ecological knowledge, in the Cook Islands, as an effective conservation tool when managing regional environmental resources.

Traditional ecological knowledge adds insights in monitoring local ecosystems, which can be useful in managing environmental resources (Berkes 2012; Crocombe 1989; Eamer 2006; Johannes 1989; Kofinas et al. 2002; Thomas 2001). It has been suggested that traditional ecological knowledge can be applied to contemporary resource management issues and that local perceptions can affect a community's capacity for

adaptation to environmental change (Berkes 2012; Dolan and Walker 2006; Rudiak-Gould 2010). Through the use of traditional ecological knowledge, gathered from community members, databases that identify and describe historical conditions of a region based on qualitative comparisons of modeled and observed environmental changes, can be developed (Johnston 2001:146; Santer and Wigley 2010:36). Traditional ecological knowledge has been use in several pilot communities in the Cook Islands, Fiji, Samoa and Vanuatu, with local community members identifying climate conditions relevant to them in order to assess present and potential adaptive strategies (Sutherland et al. 2005).

An approach based on a mix of ethnographic methods can provide a broad perspective, which can help to overcome communication difficulties between different groups of people, in order to communicate climate forecasts in a useful and culturally sensitive way (Bohannan and van der Elst 1998:72; Crane and Angrosino 1992:98; Pels 2005:92; Rudiak-Gould 2010:103). Anthropology can make a valuable contribution to the international dialogue on global warming by making information accessible and understandable to local, regional, and global policy makers and affected communities (Bohannan and van der Elst 1998:72; Crumley 2001:viii; Rudiak-Gould 2010:103).

This research model also builds on existing scholarship that recognizes the appropriateness of an anthropological approach to and the application of ethnographic methods in the assessment of environmental resources. Anthropology's commitment to holism, to combine scientific information with cultural knowledge, and to the assumption that the physical world and human societies are inextricably linked allows for the exploration of the interrelations between humans and their environments (Crumley 2001).

Anthropologists are in a position to contribute to scholarly, public, and governmental understanding of the relation between our species and its environments. Anthropological research and the use of ethnographic methods can generate baseline information of environmental factors by working with vulnerable communities to uncover local perceptions of environmental change, on-the-ground adaptation strategies, to identify and understand environmental threats, and to generate culturally appropriate strategies for reducing risk (Crumley 2001; Johnston 2001:146; Rudiak-Gould 2010:103). A wide range of methods can be used in environmental assessments and methodological flexibility creates variances in research designs but provides for site-specific projects and produce locally appropriate results (Dove 2001:99; Johnston 2001:146; Kelman et al. 2011; Rudiak-Gould 2010; Sutherland et al. 2005). This research contributes to the work of environmental anthropologists by situating traditional ecological knowledge within the context of local and regional environmental change on atoll islands in the Central Pacific, and develops data that can be used to demonstrate qualities of environmental resources.

3.4 Methods

In order to identify and describe past and present qualities of environmental resources, any changes to those resources, any effects from those changes, and any reactions to those effects, both qualitative ethnographic data and quantitative geospatial information were gathered and analyzed. Qualitative ethnographic data consists of the local perceptions of the qualities of the environmental resources, in the past and the present, any changes in those qualities, any effects of those changes, and any reactions to the effects of any changes in the qualities of environmental resources on the island. Qualities are defined as the details that describe the condition of the distinctive attributes

possessed by the resources. Changes are identified as a difference between past and present qualities. Effects are defined as any perceived impact resulting from the change in the qualities of the environmental resources. Reactions are defined as any intentional or unintentional response to change or effects of changes in environmental resources. Quantitative geospatial data consists of the identification of the GPS (UTM) coordinates of the location of past or present resources, and any changes, effects, and reactions.

Ethnographic information was gathered and analyzed at the village level. The target population of this research was the adult native inhabitants, of the twenty households within the village of Nikutoru, on the southern end of Tabiteuea Island, identified as Tabiteuea Maiaki, in the Gilbert chain of islands within the country of Kiribati, defined operationally as community members with ancestral connections to lands within Nikutoru or associated properties. The physically bounded sample population of informants was selected through quota sampling to include at least one informant from each of the twenty households associated with Nikutoru. Informants included were all adults, over 18 years of age, of all genders, and all generations. The other village members recognized every informant as established contributing members of the group. All of the informants were long-term residents of the island and had spent the majority of their lives on the land about which they were reporting.

3.4.1 Fieldwork

Qualitative ethnographic data regarding perceived qualities, changes, effects, and reactions was gathered through three methods: participant observation, interview questionnaire, and participatory mapping. Participant observation was conducted through

Figure 3.1 Map of Gilbert Islands chain.

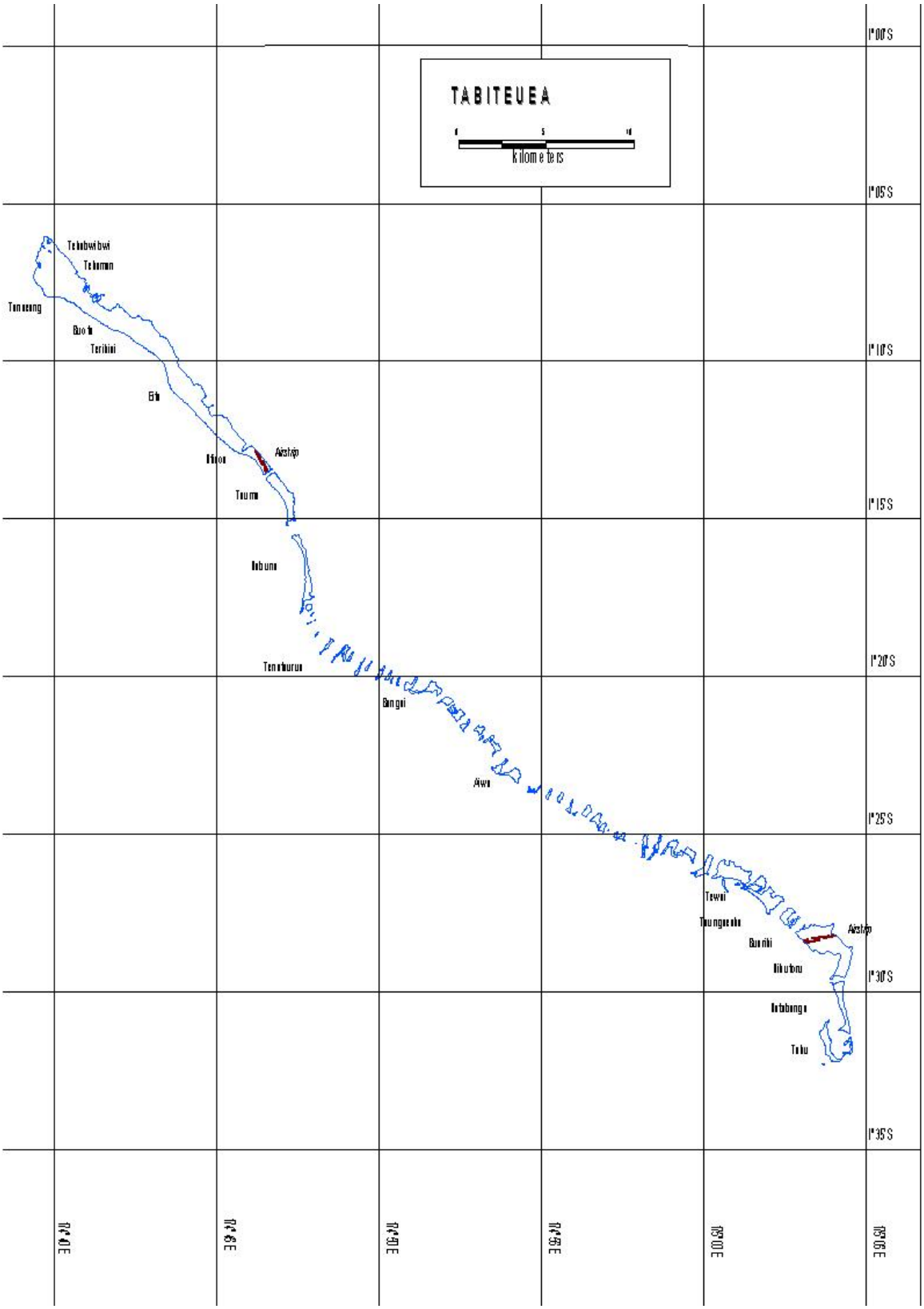

Figure 3.2 Map of Tabiteuea Island.

Figure 3.3 Ariel view of Tabiteuea Island.

Figure 3.4 Ariel view of research area: Tabiteuea Maiaki.

a homestay arrangement, appropriate participation in public and private activities, and general and focused observations. Observations were recorded in field notes. In an attempt to ensure validity, informants were asked to evaluate conclusions for accuracy. An interview questionnaire was used to elicit information regarding the past and present qualities of environmental resources, changes in those resources, effects of the changes, and reactions to the effects (see Appendix A). Culturally relevant and socially sensitive, non-leading prompts were developed and field-tested with key informants. All interviews were recorded in field notes, and relevant segments were transcribed. All information was recorded at the village level; no form of informant identification was recorded.

Quantitative geospatial data, regarding perceived qualities, changes, effects, and reactions, was gathered through three methods: participant observation, interview questionnaire, and participatory mapping. Participatory mapping was used to record the location of areas and features associated with past and present qualities of environmental resources, changes in those resources, effects of those changes, and reactions to the changes, within the bounded region of lands associated with the inhabitants of the village of Nikutoru. A handheld GPS unit was used to identify the locations and the coordinates were documented in the field notes.

Responsibilities regarding legalities, consent, and data stewardship were addressed. All proposed research methods were reviewed and approved by the University of Montana Institutional Review Board (Appendix B), and were endorsed by the Government of Kiribati through the Ministry of Internal and Social Affairs (Appendix C). Informed consent was required of all participants. Entry into the village was gained

by presenting the project to community leaders and heads of households, in order to obtain group awareness of the project. A consensus was obtained from households that agree to participate in the research, while informed consent was gathered from all individuals involved, indicating that the purposes of the research were explained to them, were fully understood, and that the informants were participating voluntarily (Crane and Angrosino 1992:146; LeCompte, et al. 1999:51.). Collecting information anonymously at the village level protected the human subject's personal privacy. The confidentiality of information has been maintained through the exclusion of all identifiers linking the subject to the specific data.

3.4.2 Data Analysis

The gathered data was analyzed to identify and describe past and present qualities of environmental resources, any change in the qualities, any effects of the changes, and any reactions to the changes in the qualities of environmental resources. All responses were aggregated for village-level analysis, which allowed for the identification of emerging patterns, comparisons of aggregated data, and anonymity of informants. Analysis began with the identification of preliminary themes in the responses through grounded theory in order to identify categories and concepts and to link the concepts (Bernard 2006:492; Glaser and Strauss 1967:28-52). Responses related to past and present qualities of environmental resources were coded based on an established inter-coder agreement of definitions. Inductive coding allowed for identification of emerging patterns and later comparison of the types of environmental resources identified (Bernard 2006:493; Strauss and Corbin 1990:61-68). Analytical categories were developed in

order to organize data and identify trends in past and present qualities of environmental resources. Descriptive analysis was applied and responses were cross-tabulated to display frequency distribution of responses (Crane and Angrosino 1992:147). Responses about past and present qualities of environmental resources were compared to identify the presence or absence of change. Presence of change was determined through reported difference in descriptions of past and present, while absence of change was determined through no reported difference in descriptions of past and present. Data gathered through participatory mapping underwent spatial data analysis to identify where past and present environmental resources were located within the bounded study site (Schensul 1999b:55; Crane and Angrosino 1992:145-146).

Chapter 4
Results

The responses from the interviews were sorted, within the cultural domain of the environment, into the cultural categories of *Tarawa* (Land), *Marawa* (Sea), and *Karawa* (Sky) (Spradley 1980:88). These are natural distinctions recognized by the people of Kiribati. The terms, or environmental resources, have been organized and analyzed within these cultural categories. Responses were analyzed both quantitatively, to show the number of responses regarding past and present qualities and perceived changes in resources, and qualitatively, to describe the past and present qualities of environmental resources, the perceived changes in those resources and the subsequent effects of and reactions to the changes identified.

4.1 Quantitative

Responses regarding past and present qualities were tabulated to identify the presence or absence of change in environmental resources on the island of Tabiteuea Maiaki. The results for environmental resources associated with *Tarawa* (Land) are presented in Table 4.1 (Appendix D). The results for environmental resources associated with *Marawa* (Sea) are presented in Table 4.2 (Appendix D). The results for environmental resources associated with *Karawa* (Sky) are presented in Table 4.3 (Appendix D). UTM coordinates for sites identified through participatory mapping are presented in Table 4.4 (Appendix E).

By comparing the total number of reports for each resource presence or absence of change can be identified. Conclusions for changes identified in environmental

TARAWA (LAND)	Resource	Quality	Past Qualities	Present Qualities	Changes in Qualities
Plants	Pandanus	Quantity (Trees)	More Trees (5)	Less Trees (4)	Less Trees (9)
		Health (Trees)	No Response (0)	Healthier Trees (1)	Healthier Trees (1)
	Coconut	Quantity (Trees)	More Trees (3)	Less Trees (3)	Less Trees (6)
		Quantity (Trees)	No Response (0)	Same Amount (1)	No Change (1)
		Health (Trees)	Healthier Trees (1)	No Response (0)	Less Healthy (1)
		Health (Trees)	No Response (0)	Healthier Trees (2)	Healthier Trees (2)
		Quantity (Fruits)	More Fruits (1)	Less Fruits (3)	Less Fruits (4)
		Quantity (Fruits)	Less Fruits (11)	More Fruits (9)	More Fruits (20)
	Breadfruit	Quantity (Fruits)	More Fruit (3)	Less Fruit (3)	Less Fruits (6)
		Quantity (Fruits)	No Response (0)	More Fruit (4)	More Fruits (4)
		Health (Trees)	No Response (0)	Healthier Trees (3)	Healthier Trees (3)
	Mangrove	Quantity (Trees)	More Trees (4)	Less Trees (2)	Less Trees (6)
	Taro Pits	Maintenance	Maintained Pits (2)	Unmaintained Pits (3)	Unmaintained Pits (5)
	Pond Grass	Presence	Pond Grass (3)	No Pond Grass (4)	No Pond Grass (7)
Invasive Species	Yellow Alder	Presence	No Flowers (2)	Flowers (4)	Flowers (6)
	Rusty Millipedes	Presence	No Millipedes (1)	Millipedes (4)	Millipedes (5)
	Beach Morning Glory	Presence	Less Vines (1)	More Vines (1)	More Vines (2)
Property	Property	Maintenance	Maintained (13)	Not Maintained (7)	Not Maintained (20)
		Use	Composted (3)	Not Compost (2)	Not Compost (5)
		Use	Worked Land (15)	Not Work Land (19)	Not Work Land (34)
		Use	No Response (0)	Work Land (4)	No Change (4)
Coastline	Tides	Height (Tide)	Lower Tideline (4)	Higher Tideline (6)	Higher Tides (10)
	General Shoreline	Condition	Less Erosion (4)	More Erosion (19)	More Erosion (23)
	Site #5	Condition	Less Erosion (2)	More Erosion (3)	More Erosion (5)
	Site #6	Condition	Less Erosion (2)	More Erosion (1)	More Erosion (3)
	Site #7	Condition	Less Erosion (1)	More Erosion (1)	More Erosion (2)
	Site #8	Condition	Less Erosion (3)	More Erosion (2)	More Erosion (5)
	Site #9	Condition	Less Erosion (3)	More Erosion (3)	More Erosion (6)
	Site #10	Condition	Less Erosion (3)	More Erosion (3)	More Erosion (6)
	General Shoreline	Condition	No Response (0)	Deposition (3)	Deposition (3)
	Site #11	Condition	No Deposition (7)	Deposition (4)	Deposition (11)
	Site #12	Condition	No Deposition (2)	Deposition (2)	Deposition (4)
Roads	Paths	Permanence	Impermanent (7)	Permanent (4)	Permanent (11)
	Causeway	Presence	No Causeway (6)	Causeways (3)	Causeways (9)
	Site #14	Condition	Deposition (6)	More Erosion (4)	More Erosion (10)
	Site #15	Condition	Less Erosion (1)	More Erosion (3)	More Erosion (4)
	Site #16	Condition	Less Erosion (1)	More Erosion (2)	More Erosion (3)

Table 4.1 Tabulated Responses for *Tarawa* (Land) Resources

MARAWA (SEA)	Resource	Quality	Past Qualities	Present Qualities	Changes in Qualities
Fish	Pond Fish	Quantity (Fish)	More Fish (2)	Less Fish (1)	Less Fish (3)
		Health (Fish)	No Response (0)	Healthier Fish (2)	Healthier Fish (2)
	Ocean Fish	Quantity (Fish)	More Fish (15)	Less Fish (11)	Less Fish (26)
		Quantity (Fish)	No Response (0)	Same Fish (3)	No Change (3)
		Quantity (Species)	More Species (8)	Less Species (12)	Less Species (20)
		Quantity (Species)	No Response (0)	New Species (1)	New Species (1)
		Size (Fish)	No Response (0)	Smaller Fish (3)	Smaller Fish (3)
		Location (Fish)	No Response (0)	Diferent Location (2)	Different Location (2)
	Coral	Health (Coral)	Healthier (2)	Less Healthy (2)	Less Healthy (3)
Water	Waves	Height	No response (0)	Higher Waves (5)	Higher Waves (5)
	Water Temperature	Temperature	Cooler Water (1)	Warmer Water (1)	Warmer Water (2)

Table 4.2 Tabulated Responses for *Marawa* (Sea) Resources

KARAWA (SKY)	Resource	Quality	Past Qualities	Present Qualities	Changes in Qualities
Seasons	**Seasons**	Regularity	Regular Seasons (9)	Irregular Seasons (15)	Irregular Seasons (24)
Weather	**Sunshine**	Quantity (Sun)	Less Sun (2)	More Sun (5)	More Sun (7)
		Quantity (Sun)	More Sun (8)	Less Sun (2)	Less Sun (10)
		Quantity (Sun)	No Response (0)	Same Sun (1)	No Change (1)
	Air Temperature	Temperature	Cooler (3)	Warmer (2)	Warmer (5)
		Temperature	No Response (0)	Cooler (2)	Cooler (2)
		Temperature	No Response (0)	Same Temperature (1)	No Change (1)
	Rain	Quantity (Rain)	Less Rain (10)	More Rain (21)	More Rain (31)
		Quantity (Rain)	More Rain (3)	Less Rain (1)	Less Rain (4)
		Quantity (Rain)	No Response (0)	Same Rain (1)	No Change (1)
	Wind	Quantity (Wind)	No Response (0)	More Wind (1)	More Wind (1)
		Strength (Wind)	No Response (0)	Stronger Wind (5)	Stronger Wind (5)
		Direction (Wind)	From West (5)	Different Direction (8)	Different Direction (13)
		Direction (Wind)	No Response (0)	Same Direction (2)	Same Direction (2)
	Storms	Quantity (Storms)	Less Storms (1)	More Storms (4)	More Storms (5)
		Strength (Storms)	No Response (0)	Stronger Storms (2)	Stronger Storms (2)
		Quality (Storms)	No Response (0)	Same Storms (1)	Same Storms (1)

Table 4.3 Tabulated Responses for *Karawa* (Sky) Resources

Site	Coordinates	
#01	S 001 28 47.4	E 175 04 19.4
#02	S 001 28 51.9	E 175 04 02.3
#03	S 001 28 56.3	E 175 04 04.7
#04	S 001 27 35.8	E 175 02 21.7
#05	S 001 29 27.1	E 175 04 35.8
#06	S 001 29 07.4	E 175 04 19.9
#07	S 001 28 16.5	E 175 03 01.6
#08	S 001 28 56.0	E 175 04 04.3
#09	S 001 28 55.1	E 175 04 01.8
#10	S 001 28 55.5	E 175 04 02.6
#11	S 001 28 54.2	E 175 04 00.9
#12	S 001 29 00.0	E 175 04 19.2
#13	S 001 28 17.2	E 175 02 59.6
#14	S 001 29 53.9	E 175 04 05.5
#15	S 001 27 51.0	E 175 02 59.6
#16	S 001 29 39.0	E 175 04 10.9

Table 4.4 UTM Coordinates for Identified Sites

resources are detailed here. There was one (1) report of no change in quantity of trees and twenty-one (21) reports of less trees, indicating a presence of change in the resource, specifically a decrease in the quantity of trees. There was one (1) report of less healthy trees and six (6) reports of healthier trees, indicating a presence of change in the resource, specifically of healthier trees. There were ten (10) reports of less fruit and twenty-four

(24) reports of more fruit, indicating a presence of change in the resource, specifically an increase in the amount of fruit. There were sixty-four (64) reports of unmaintained and unused resources and four (4) reports of used resources, indicating a presence of change in the resource, specifically a decrease in the maintenance and use of resources. There were sixty-seven (67) reports of more erosion and zero (0) reports of less erosion, indicating a presence of change in the resource, specifically an increase in erosion. There were eighteen (18) reports of increased deposition and zero (0) reports of decreased deposition, indicating a presence of change in the resource, specifically an increase in deposition. When the changes of erosion and deposition were compared, there were forty-nine (49) more reports of erosion than deposition indicating erosion as the dominant change but both indicating shoreline instability. There were seven (7) reports of no pond grass and zero (0) reports of pond grass, indicating a presence of change in the resource, specifically a decreased amount of pond grass. There were thirteen reports of invasive species and zero (0) reports of no invasive species, indicating a presence of change in the resource, specifically an increase in invasive species. There were ten (10) reports of higher tidelines and zero (0) reports of lower tidelines, indicating a presence of change in the resource, specifically higher tidelines. There were twenty (20) reports of more roads or causeways and zero (0) reports of less roads and causeways, indicating a presence of change in the resource, specifically more roads and causeways. There were two (3) reports of less pond fish and zero (0) reports of more pond fish, indicating a presence of change in the resource, specifically less pond fish. There were two (2) reports of healthier pond fish and zero (0) reports of less healthy pond fish, indicating a presence of change in the resource, specifically healthier pond fish. There were twenty-six (26)

reports of less ocean fish and three (3) reports of the same amount of ocean fish, indicating a presence of change in the resource, specifically less ocean fish. There were twenty (20) reports of less ocean fish species and one (1) report of more ocean fish species, indicating a change in the resource, specifically less ocean fish species. There were three (3) reports of smaller fish and zero (0) reports of larger fish, indicating a presence of change in the resource, specifically smaller fish. There were two (2) reports of fish in different locations and zero (0) reports of fish in the same locations, indicating a presence of change in the resource, specifically fish in different locations. There were two (2) reports of less healthy coral and zero (0) reports of healthier coral, indicating a presence of change in the resource, specifically less healthy coral. There were five (5) reports of higher waves and zero (0) reports of lower waves, indicating a presence of change in the resource, specifically higher waves. There were two (2) reports of warmer water and zero (0) reports of cooler water, indicating a presence of change in resources, specifically warmer water. There were twenty-four reports of irregular seasons and zero (0) reports of regular seasons, indicating a change in the resource, specifically irregular seasons. There were seven (7) reports of more sunshine and ten (10) reports of less sunshine and one (1) report of no change in the amount of sunshine, indicating a presence of change in the resource, specifically less sunshine. There were five (5) reports of warmer air temperatures and two (2) reports of cooler air temperatures and one (1) report of the same air temperature, indicating a change in the resource, specifically warmer air temperatures. There were thirty-one (31) reports of more rain and four (4) reports of less rain and one (1) report of the same amount of rain, indicating a presence of change in the resource, specifically more rain. There was one (1) report of more wind and zero (0)

reports of less wind, indicating a presence of change in the resource, specifically more wind. There were five (5) reports of stronger wind and zero (0) reports of weaker wind, indicating a presence of change in the resource, specifically stronger wind. There were thirteen (13) reports of wind from different directions and two (2) reports of wind from the same directions, indicating a presence of change in the resource, specifically wind from different directions. There were five (5) reports of more storms and zero (0) reports of less storms, indicating a presence of change in the resource, specifically more storms. There were two (2) reports of stronger storms and zero (0) reports of weaker storms and one (1) report of the same strength storms, indicating a presence of change in the resource, specifically stronger storms.

4.2 Qualitative

The responses gathered regarding past and present qualities of environmental resources, the changes in those qualities, along with the effects of the changes identified, and reactions to the effects of those changes in the qualities of environmental resources on the island, are described in the following sections.

4.2.1 *Tarawa* (Land)

The informants identified environmental resources on the land that were coded and organized into the categories of Plants, Invasive Species, Property, Coastlines, and Roads. Included in their responses and described here were the resources that did and did not change, along with the perceived effects of the changes and their reactions to the effects of those changes.

Plants

The plants that were mentioned by the informants were pandanus (*Pandanus tectorius*), coconut (*Cocos nucifera*), breadfruit (*Artocarpus altilis*), and mangrove trees (*Rhizophora stylosa*), along with the giant swamp taro (*Cyrtosperma chamissonis*) grown in pits and the sedge (*Cyperus laevigatus*) that grows along the banks of the brackish fishponds.

It was mentioned that there used to be more pandanus (*te kaina*) but that now there are less, signifying a change in the resource even though the pandanus are reportedly healthier. The informants expressed that it was hotter now as an effect of there being less trees due to the reportedly less shade but they said there was little effort to replant the pandanus trees and that the islanders were continuing to cut down the existing trees in reaction to the increased health of the pandanus.

It was also reported that there are less coconut trees (*te nii*) than there were in the past but that the trees are healthier now, although one informant did claim that the trees were healthier in the past and another said that there was no change in the number of trees between now and then. And, while it was mentioned four times that there was a decrease in the number of coconuts (*te ben*), the majority of informants recognized that there are more nuts being produced by the coconut trees now than there were in the past. Informants also claimed that an increase in air temperature is an effect of fewer coconut trees but still aren't making much effort to replant them while cutting down mature trees for building supplies and to clear land. Those who said that presently there were fewer nuts available remarked that they ate rice and canned goods when there were not enough nuts for food. Those who acknowledged an increase in the amount of nuts available

stated that there was now an excess of the resource. In contrast to the previously scarce resource, many informants admitted to their recent ability to make a profit off of the nuts. In reaction to the increase in nuts, the islanders disregarded the previous agreement to not gather nuts for use in purchasing tobacco or kava. Although it had always been acceptable to collect nuts for food or copra, the villagers had agreed to a one hundred dollar fine if caught selling or trading the nuts for other purposes. The current abundance has led the people to ignore the restriction and they are responding by collecting the nuts for sale or trade. The informants also pointed out that they are reacting to the increase in nuts by cutting copra all year long, providing them with a source of money to buy imported foods.

Responses gathered about the breadfruit trees (*te mai*) show that the majority of informants perceive there to be a decrease in the quantity of fruits available while unanimously reporting that the breadfruit trees are healthier now and that some trees, thought to be dead, were showing signs of regrowth. Those informants whom considered there to previously be more fruit claimed that the trees produced better in the sunnier weather of the past. Some informants claimed that they were unable to eat the fruit as often as an effect of the diminished resource, while others disclosed their efforts to plant more breadfruit trees in reaction to the perceived increase in the health of the trees.

In the past, the mangroves, locally known as *te tongo*, were reportedly, full of sand and thick with branches, used to protect the lagoon shoreline, but now they are not used and have been cut down in front of the village. As an effect of there being less mangrove trees, more sand washes away from the beaches and fish are concentrated in the few clumps of mangroves that remain. The area previously had large areas of

mangroves along the lagoon shore but the majority of them were cut down after the village members decided that socially unacceptable activities were occurring in the area. Due to the unfavorable incidences that had happened around the mangroves, the informants divulged their reluctance to replant any mangroves, instead choosing to use *te bwiibwii*, a traditional strategy of using sticks and palm fronds to buffer the coastline, or *te bono*, a seawall piled up with coral slabs, to protect their shores.

The informants explained that, in the past, many of the pits of giant swamp taro (*te bwabwai*) had been full of mature plants, well maintained by families that worked together during dry seasons when the water levels were low, but that most were currently unmaintained. The taro pits that had been left untended were described as now being full of wild pandanus, coconut trees, and even rubbish. Because of the change, it was reported that fewer people were familiar with the traditional skill of cultivating taro, leading the community to rely on a smaller number of people to provide the important ceremonial crop. The loss of maintained taro pits, in effect, reduced the amount of taro available for ceremonies, to which informants admitted to resorting to a *bubuti*, or request that cannot be denied, for other community members to provide the scarce resource.

The sedge, *te maunei*, that grows around the edge of the fishponds has been used for generations to make skirts for women but, while reportedly growing well during drier times in the past, it is notably absent under the current wetter conditions (Autio 2010:496; Koch 1986:132-134). The informants explained that they were unable to make their traditional skirts, called *te riri maunei*, due to the lack of pond sedge but followed up their comments with a reassurance that it would regrow once the land dried out and there was more sunshine. A location previously visited for collecting pond sedge in order to

make traditional skirts was identified through participatory mapping as Site #01 and the coordinates were recorded along with a photograph (see Figure 4.1) documenting the absence of *te maunei* growing on the pond shoreline.

Figure 4.1 Site #01: Fishpond with notable absence of pond sedge.

Invasive Species

The informants identified three types of invasive species. The Yellow Alder (*Turnera ulmifolia*), called *te buraroti* by the locals, and Rusty Millipedes (*Trigoniulus corallines*), known simply as "the red" (*te uraura*), are both species that have been introduced to the island environment, while the Beach Morning Glory, *te ruku* (*Ipomoea pes-caprae*), is native to islands in the Pacific.

A local story suggests that Yellow Alder was introduced to the island environment when missionaries planted them for decoration in the church gardens. Although there were no Yellow Alder anywhere on the island prior to that, the yellow flowers have now spread prolifically beyond the confines of church property and naturalized across the island (Space and Imada 2004:11). In some areas, the yellow flowers crowd out other plants, such as *te nuun*, (*Morinda citrifolia*), and hinder the growth and development of more useful plant resources. Aside from the few people who try to clear them away and burn large swaths of the yellow flowers in reaction to their inundation or those who cut paths through the tall fields, most informants simply complain about the pestilent presence of the Yellow Alder. The flowers are inedible by humans and animals but some islanders have found a use for them and have begun to incorporate them as decoration in their traditional floral weavings and in vases on religious alters. Site #02 was identified through participatory mapping as one of the areas on the island that was heavily affected by the Yellow Alder. Figure 4.2 shows a particularly dense area that was inundated with the invasive species. The researcher is 6' tall and is shown in Figure 4.2 for scale standing next to a *nuun* tree that has been stunted as an effect of crowding by the *buraroti*.

Figure 4.2 Site #02: Invasive *Turnera ulmifolia* crowding native *Morinda citrifolia*.

Some informants attribute the Rusty Millipedes to the influx of Yellow Alder, while others suggest that they were unintentionally introduced as stowaways on imported lumber, but, regardless, the millipedes were reportedly never observed on the island in the past. The Rusty Millipedes only appear after a rain and, since they have no natural predators on the island and nothing will eat them, the islanders make a great effort of stepping on and killing them (see Figure 4.3). Informants complain of a red mark on their skin if they come into contact with a millipede and describe them as smelling of bleach when killed, so that most people try to regularly avoid them.

Figure 4.3 Rusty Millipedes on path after rain.

Although the Beach Morning Glory is indigenous to the region and has been found on the island in the past, the informants reported a change in the distribution of the vine, designating a current increase in the spread of *te ruku*. While the vine is pantropical and found throughout all archipelagos in Micronesia, it is uncommon on atolls (Whistler 1992:125). The vine is now taking over large areas, climbing over and choking out other vegetation, to which the islanders react by leaving the land fallow. Despite numerous areas shown that were affected by the vine, Site #3 (Figure 4.4) was identified through participatory mapping.

Figure 4.4 Site #03: Former residential area overrun with Beach Morning Glory.

Property

When asked about the environmental resources on the island (*te aba*), informants included in the discussion descriptions of the properties they inherited from their ancestors. Their comments focused on how they managed and utilized the resources within their pieces of land, specifically on maintenance, composting, and whether or not they worked the land.

Properties were more likely to be maintained in the past, when the village was said to be cleaner and cleared of rubbish. One informant even described it as "more hygienic" in the past while many said that there was less grass around the houses unlike the weeds common today. Many people complained of the current lack of maintenance, on both house sites and bush land. Despite their complaints about the yard waste and trash lying around and about the increase in weeds, most of the islanders respond by continuing to leave it to rot. In the past, much of the yard waste was collected for compost and used to grow plant resources like the giant swamp taro and the breadfruit but nowadays, if it is collected at all, the yard waste is burnt or discarded without utilizing it.

The informants expressed concern for the change in the amount of people who worked the land. In the past, the majority of the people who lived on the island were engaged in working their land and the environmental resources around them. It was common for people to grow food plants such as bananas, coconuts, and papaya. Islanders regularly worked in their gardens during the wet seasons when they planted the coconuts and pandanus they had collected and stored throughout the year. Although four people disclosed that they are still working the land by growing coconut, pandanus, papaya (*te*

bwabwaia), and pumpkin (*te baukin*) around the house, in addition to coconut on bush land, the general decrease in the amount of land now worked was mentioned thirty four times. Those who are gardening make an effort to protect their resources from dogs, pigs, and children by building a fence around their crops. As for the rest of the population who are not growing food plants, different reasons were used to explain the fact that they are not working their lands. Some said that they don't garden because they just let the fruits fall and grow randomly on their own, while one man said he was too busy drinking kava to be bothered with working the land. A few informants complained that less people work the land because the younger generations refuse to learn and that there are few young men willing to work land. Most people admitted to only collecting coconuts from their properties and not doing any other work to produce food plants. The reduction in people working the land has affected the community in multiple ways. As the amount of unused land increases, people have become less familiar with the boundaries of the properties that belonged to their ancestors. As less people work the land, or even know how, some resources, such as banana trees and taro pits that were previously actively cultivated, are not passed on to the next generations but instead are left untended and the land allowed to go fallow. There are a few previously managed plants that still survive, such as the last native fig (*Ficus tinctoria*), locally known as *te bero* (shown in Figure 4.5), that remain on the island but others, such as whole groves of mature coconut trees, are dying off. Another effect of the land not being worked as much as in the past is that two people expressed the desire to work their land in order to grow the food resources that provide a balanced nutrition for their families. One informant even went so far as to prepare the land for planting a garden. The islander had learned

new techniques at a government-sponsored workshop at which the lead agriculturalist had promised seeds to whoever prepped their land. But after digging holes and filling them with compost, the seeds were never delivered and the informant admitted to abandoning the garden without further working the land.

Figure 4.5 The last remaining native fig tree (*Ficus tinctoria*).

Coastline

The coastline (*te bike*) was often a topic of discussion when interviewing informants. The islanders pointed out changes that they observed along their shorelines that have been organized into categories that can be described as Tides, Erosion, and Deposition. Specific locations were provided as examples to demonstrate the informants' claims of changes in the environmental resource of their island.

The past tideline was said to have been farther from the shore and the lagoon was said to be deeper closer to the coast but present day tides have been observed reaching up to the road, with a higher sea level, locally referred to as *te buti*, claimed to be directly affecting island resources. While generally referred to as "not good," the higher tides have flooded habitation areas and the islanders have reacted by either building *te bwiibwii* and *te bono* or relocating affected structures and settlements further inland or to another location. The salt water has started to enter the fishponds during high tides, impacting the health of the fish that do not thrive in water that is too saline. The higher tides have also left the ancient stone fish traps or weirs (*te ma*) completely underwater (Dieudonne 2002:25-32; Koch 1986:14-15). As seen in Figure 4.6 of the fish trap mapped as Site #04, some of the fish traps that have been used for many generations are now abandoned because they are no longer efficient for catching fish when completely submerged under water. Some of the weirs belong to families that have maintained them for many generations while other traps are shared by an entire village but as a result of the flooded weirs, most of the fish traps have been left them untended and allow them to be used by anyone who wishes to try to utilize them. Many of *te ma* are falling into disrepair with stone walls collapsing and sand filling in their centers.

Figure 4.6 Site #04: Previously managed fish trap, now submerged and abandoned.

Kanakinako, the local term for erosion, was reportedly not much of a concern in the past. Informants explained that, prior to European colonization, their settlements had been more spread out across the island and generally located in the interior of the island, as opposed to the consolidated villages along the coastline that were later established and currently inhabited. The islanders also stressed that they used to move "with the land," meaning that they were less sedentary and could more easily change location if there was any change in the landscape. They remembered there to be less erosion occurring and more sand on the beaches in prior times. When they did experience areas of erosion, the informants build *te bwiibwii*, which they felt sufficiently protected their properties against further erosion. The comments regarding the past condition of the coastline were in stark

contrast with those describing the current state of the shoreline. The current condition of the island was often said to be "broken." The villagers elaborated on this claim by providing descriptions of eroded areas, lost beaches, and fallen palms. While *te bono* is a more permanent installment that will endure the force of the waves and tides, some informants explained that erosion can still occur under and around the coral slabs, making *te bwiibwii* the preferred strategy to protect the coastline because the water can move through the sticks and fronds and even collect more sand deposits. It was reported that the general loss of shoreline was most commonly responded to with *te bwiibwii* and *te bono* although some informants admitted to making no effort to protect areas affected by erosion.

In addition to the general remarks about an increase in erosion, the informants provided six strong examples of areas actively eroding, pointing out the environmental change from the past. In the first example, identified as Site #05, the beach has always been known for its rocky shoreline but the recent erosion has created a sandy beach (see Figure 4.7). This area in particular is of significance to the village of Nikutoru because it is central to their origin story and is a place that figures into their group identity. The informants expressed their concern about the changes occurring at this location because the erosion has threatened burials within the site, which was the location of their ancestral village. Although most people had relocated to the current village, some had remained and continued to use their properties in the area but the site is now completely uninhabited due to the coastal inundation or seawater and erosion. Although the old village site is no longer occupied, most of the informants referred to the area in some way during the interviews.

Figure 4.7 Site #05: Previously rocky shoreline is now a sandy beach.

The second site identified as an example of erosion previously had *te bwiibwii* built along the lagoon shoreline that was further out than where the present day beach was located. The remains of *te bwiibwii*, which is built parallel to the coastline to prevent erosion of sand, had long ago been washed away and been replaced with *te wae ni kai*, which is built perpendicular to the shore in order to collect sand and build up the beach. The structure was mapped as Site #06 and can be seen in Figure 4.8 along with the resulting spit of land that has formed down shore. The property owner has planted mangroves and a grove of coconut trees on the new land in response to the deposition of sand and in an effort to prevent further erosion in the area. *Te wae ni kai* has fallen into disrepair after the abandonment of the settlement at the location of Site #06.

Figure 4.8 Site #06: Efforts to combat erosion, with *te wae ni kai* in foreground and newly planted mangroves in background.

The atoll environment on Tabiteuea Maiaki consists of a string of islets separated by natural channels through which water ebbs and flows from the ocean to the lagoon. In the past, the coastline of the channels, while fluctuating to some degree, remained relatively consistent. The informants offered Site #07 as an example of environmental change, describing the area as having a previously stable shoreline that was heavily eroded after the construction of a causeway across the channel. The loss of land and the occasional flooding of the properties threatened the house structures built along the channel. The households lost a significant amount of land before *te bono* were built along the waterline and backfilled with sand, stones, fronds and trash. Figure 4.9 shows *te bono* at low tide, with the causeway in the background, while Figure 4.10, looking

Figure 4.9 Site #07: Effort to shore-up property with *te bono* (low tide).

Figure 4.10 Site #07: Efforts to shore-up property with *te bono* (high tide).

back from the causeway, shows just how close the water gets in the same area at high tide, right up against *te bono*.

Another example of erosion provided was Site #08, the village *mwaneaba*, (community meeting house). This structure is of symbolic and practical importance to the community, the former due to its representation of ancestral connections of people and positions, and, the latter due to its use as a place to conduct meetings and ceremonies (Alkire 1977:80; D'Avella 1998:145; Goodenough 1963:362; Grimble 1989:197-251; Kaeppler 2008:144; Luke 1962:157-158; Mason 1968b:293; Talu 1979:38-40). This *mwaneaba* at Site #08 was further out toward the lagoon before and had a thick grove of mangroves protecting it from the tides and waves, but the mangroves have since been cut

down, due to socially unacceptable activities in the area, and the *mwaneaba* was relocated further up the beach, in order to protect it from the encroaching waterline. The villagers built *te bwiibwii* along the lagoon shore for further protection of the structure but it has since washed away and is currently ineffective with only vertical sticks remaining (Figure 4.11). The informants openly admitted to their current negligence of fixing *te bwiibwii*, in effect leaving the *mwaneaba* exposed to tidal flooding. In response, the villagers have switched to using the local church *mwaneaba* as the place to conduct their community events. The *mwaneaba* at Site #08 is only infrequently occupied by a group of men who use the traditional structure as a place to gather in order to drink kava together in the evenings.

Figure 4.11 Site #08: Village *mwaneaba* abandoned due to flooding.

The church *mwaneaba*, Site #09, was also affected by erosion. There was a *bwiiwii* that helped slow the water but the area continued to flood. *Te bono,* seen in Figure 4.12, was built in response. The permanent break wall effectively stopped the tidal influx and extended the land area, providing more usable space, but prevents the beaching of the church boat which must be stored elsewhere.

The final example provided by the informants that demonstrated their perception of change in environmental resources due to erosion was at Site #10. The house that stands there was described as having been farther inland from the waterline, that is, that the tideline was farther out in the lagoon, away from the house but that due to erosion, despite the *bwiibwii* that used to protect the area, the sand in front of the house had washed away. The water was said to have increasingly come closer to the house until the inhabitants built *te bono* to protect their property. In response to the loss of land, and after building the permanent break wall, the family also built a stilted house that was above the water at high tide but accessed from the dry land from the edge of *te bono*.

Although the informants mostly mentioned the effects of erosion on their coastline, they also pointed out the areas that sand deposited along the shore. There were two examples provided of areas where there was so much deposition of sand that there was an increase in usable land area and new houses built on the properties. At both Site #11 and Site #12, the lagoon was said to have gone up to the road in the past. Some of the older informants reminisced about having played soccer as children in the open lagoon flat that was Site #11, which is now a house site and a local store. The new inhabitants of Site #11 explain that the new land area does not drain well but instead puddles when it rains. They also mentioned that the area tends to flood during high tides,

Figure 4.12 Site #09: *Te bono* protecting the church *mwaneaba*.

with water reaching the house and store but admit to taking no action to protect the shoreline, adding that more sand continues to deposit on their shore. The house on Site #12 was previously on the other side of the road, with an estimated increase of about 40 meters of sandy beach deposited. The house has since been relocated to the new side of the road, closer to the lagoon shore. No erosion is reported but, just like Site #11, more sand continues to arrive. The new land at Site #12 is also affected by flooding to which the inhabitants reacted by planting mangroves and *te bwiibwii* to protect the shoreline and promote deposition. Their efforts are said to block the wind and slow the waves, while increasing the fish in the area.

Roads

In the past, there were no roads (*te kawai*) on the island, only paths on which to travel the atoll. The paths were impermanent, easily altered around degraded areas or rerouted to new destinations. Since then, permanent roads have been built, which are not easily altered. The people tend to keep to the main roads, leaving many of the old paths to be reclaimed by overgrown plants and trails to be forgotten. The roads, due to heavy bicycle, motorcycle and car traffic, show wear and informants complained about the holes and puddles, shown in Figure 4.13, that have developed in most areas along the route. The conditions have forced the islanders to slow down along the road and have resulted in more accidents as drivers swerve to avoid potholes and other obstacles. The informants claimed to have tried to maintain the road themselves, by filling in the holes with stones and clearing the ever-accumulating obstructions of palm fronds and coconuts, but that after the rain the roads return to their poor condition and the people have stopped trying to fix the problem areas.

Figure 4.13 Local dirt road with holes and puddles.

There were no causeways before the government built the structures in the 1970s, connecting all of the islets except for the southern most one with the village of Taaku. Islanders would walk across the channels at low tide or swim if the water was high or ride in *te ua*, a local outrigger canoe, to get across to neighboring islets. The open channels allowed for a natural movement of sand between the ocean and lagoon, which flowed with a current that was slower than it is now. Informants stressed that foreign consultants advised the government against building the causeways but that the citizens of Kiribati insisted on the construction. Once the causeways were built, and the effects began to be noticed by the islanders, the people from the village of Taaku abandoned their efforts to build a causeway. The causeway to Taaku was left unfinished despite having already received the funding and the inhabitants of the islet chose to use a ferry as an alternative to crossing the channel during high tides, although many still wade across in the chest-high water when necessary. The causeways are blamed for much of the erosion around the island, causing fallen palms and exposed roots as sand is washed away by water that is trapped by the barricades that are the causeways. When informants spoke of erosion, many also spoke of deposition, stating that the sand that eroded from one area has deposited in another, such as the new land at Site #11. The causeways have created strong currents in the channels and deeper water as the tides flow through the narrow tunnels that allow saltwater to flow between the lagoon and the ocean. Jetties were built at Site #13 to try and divert the energy of the water moving through the culverts but are not perceived to be helping the situation. Figure 4.14 shows the causeway, and jetties to the left, at Site #13 during low tide, with the dark water demonstrating the depth of the channel in front of the culvert, while Figure 4.15 displays the same jetties during high

tide, with the ripples and whitewater in the bottom left as evidence of the strength of the current coming through the pipe. In the past, children enjoyed jumping off the causeway and swimming in the channel but the area has become too dangerous due to the strong tidal flow. Nowadays, less people fish in the channels than in the past and many are afraid to enter the fast moving water. Although the causeways have facilitated intra-islet travel, they have effectively changed the environment so that people can't get across the channels without the causeways. The causeways are also blamed by the informants for the loss of certain species in the lagoon. It was reported that whales and dolphins were frequently abundant in the waters around the islet of Taaku but that are now absent from those areas since construction of the causeways.

Figure 4.14 Site #13: Causeway and channel, with jetties, during low tide.

Figure 4.15 Site #13: Channel jetties during high tide.

Three areas were pointed out by informants, through the Participatory Mapping process, as examples of erosion that had directly affected the roads and causeways. Site #14 is a causeway that had previously experienced extensive deposition but that was presently washing away. While there had been no land between the two islets before, after the development of the causeway, the coral slabs were completely covered with deposits of sand. The sand was explained to have previously come and gone in a naturally occurring cycle, but informants expressed surprise that the sand was now only disappearing. Informants identified the area as currently affected by erosion along the entire lagoon shoreline, exposing roots and toppling trees, as seen in Figure 4.16. One area had even washed away enough sand to expose the original foundation of coral slabs.

Figure 4.16 Site #14: Evidence of erosion along lagoon shoreline.

Site #15 is an example of erosion so severe that the road was rerouted and the government of Kiribati paid to have the area protected with an elaborate *bwiibwii*. Originally, the road was near the shore but much of the road has washed away, leaving it currently impassable by anything except pedestrians. The before photo (Figure 4.17), taken in 2010, and the after photo (Figure 4.18), taken in 2015, exhibit evidence of the amount of erosion that occurred in five years. It can be seen that many of the trees that had been leaning out over the lagoon had since fallen and that the shoreline had retreated behind them. The photos also show, in the bottom left foreground, that vegetation has decreased and that the sand has been washed across the road. Looking north from that location, Figure 4.19 shows how the *bwiibwii* buffers the road and how narrow the previously navigable passage has become.

Figure 4.17 Site #15: Condition of Site #15 in 2010.

Figure 4.18 Site #15: Condition of Site #15 in 2015.

Figure 4.19 Site #15: View of *bwiibwii* and road.

Another road that has eroded is Site #16, which was previously routed to flank the ocean-side of the inlet. The sand has washed away, undermining the hard top layer of the road, which has cracked and broken away, making the road impassable (see Figure 4.20). The islanders have responded to the change in their environment by rerouting the road inland, as can be seen in Figure 4.21, which shows the old road along the shore to the left and the new track through the vegetation to the right.

Figure 4.20 Site #16: Previous road with evidence of erosion in the foreground.

Figure 4.21 Site #16: Rerouting of road in reaction to erosion.

4.2.2 *Marawa* (Sea)

The informants identified environmental resources associated with the ocean that were coded and organized into the categories of Fish and Water. Included in their responses and described here were the resources that did and did not change, along with the perceived effects of the changes and their reactions to the effects of the changes in their environmental resources.

Fish

The topic of fish (*te ika*) was often discussed due to the cultural preference of the resources as a food source. The comments were divided into these types of resources:

Pond Fish, Ocean Fish, and Coral. While pond fish are not actually found in the ocean, they are included in this section through their association as an aquatic resource.

The ponds on Tabiteuea Maiaki have been family owned and maintained for multiple generations. In the past, the population relied on *te baniaua*, milkfish (*Chanos chanos*), as an important food resource and ate them regularly (Dieudonne 2002:28-31). But many ponds now have low stock due to past harvesting. A few years ago, the water level in the ponds was getting low and the milkfish population was at risk, so the majority of the fish were harvested before they died. Unfortunately, those ponds have not been restocked since then and the population has been slow to recover despite the current higher water. The fish that are still in the ponds are reportedly healthier now than before due to the increased rain that has added fresh water to the ponds. Because of the limited availability of the fish in their ponds, the islanders do not eat them as frequently from their own ponds but instead buy milkfish from a government-maintained pond on another area of the island. The low productivity of the ancestral ponds has resulted in them being left untended and some have begun to fill in with silt, further diminishing the returns.

The ocean has always served as a resource for the islanders. In the past, they developed preferences and traditions involving different species of fish that they caught. The informants perceived that in the past the waters around their island were more abundant with the types of fish they preferred. Informants claimed that before they had been able to easily catch enough fish to feed themselves and their families and often had enough to salt and dry for long-term storage. While a few people suggested that there was no change in the number of fish available and that fishing had been, and always will be, "hit or miss," most people recognized a change in the resource and stated that fish

stocks had declined. Not only was there a reported general decrease in the number of fish but also less species available, preventing the islanders from serving traditional meals based on specific species. One such example is the decline in whales (*te kua*). In the past, whales were thought to beach themselves when a village built a new *mwaneaba* in accordance with customary ways. But recent structures have been erected using modern methods, leading locals to claim that the loss of tradition has prevented whales from visiting their shores. Another example is that a few families are known across the island for serving the small fish that have historically congregated in the lagoon waters near their properties. When visitors arrive in their homes, those families are proud to serve the special fish but, in recent years, the fish have not arrived in the regular areas and those families expressed embarrassment for their inability to continue the tradition. Some informants say that the fish have moved into different areas while others contest that the fish are gone completely. One informant declared that, despite the general decline, there was also a new species of fish found in the waters of Kiribati that had never been caught there in the past. A common complaint, when discussing fish as an environmental resource, was that the fish that were being caught nowadays were significantly smaller than those caught in the past. The fish in Figure 4.22 and Figure 4.23 demonstrate a typical catch and reinforce the claim that the fish caught tend to be smaller than in the past.

The effects of less fish, and smaller fish, are that the people finish them quickly, with no extras to preserve for later, and that the current fish population serves as an irregular food source. The informants report that they need to fish more often in order to provide food for their families and that they are less selective of the fish they gather,

Figure 4.22 Sample representation of typical fish species caught.

Figure 4.23 Sample representation of typical fish species caught.

collecting any fish they find, even the young and less desirable ones. They are also disregarding regulations that protect certain species. In the past, there were rules about fishing that were implemented by the village about where and when to fish, and some species were protected by families as ancestral totems, which they were forbidden to consume. Many of those conservation methods have been abandoned as the current population struggles in response to environmental change. The current-day government has legislation restricting the hunting of different species but has difficulties enforcing the laws on outer islands. One such rule is the taking of beached green turtles (*Chelonia mydas*). Sea turtles, *te on*, is a species that is often relied upon to supplement local diet because it can be kept alive for days until ready to be processed, while the meat and eggs provide enough to feed many people. When the islanders have a limited amount of fish, some will make soup with those available, in order to feed more with less. By cutting up the fish and mixing it with coconut cream and local leaves, such as *te buka* (*Pisonia grandis*) and *te ango* (*Premna serratifolia*), the small amount of fish can be served to a larger number of people. *Te ango* has only recently been included as filler in the local diet in response to the need for more locally available foods. The islanders had previously considered the plant poisonous until government workshops were provided that explained how to prepare the leaves for inclusion in meals. If there still is not enough, the islanders rely on alternative food sources such as rice and flour, canned goods, coconuts, breadfruit, and shellfish. Some informants discussed the benefits of gardening when fish are scarce but, as mentioned previously, few actually work the land in reaction to the changing resource. Another effect of reduced fish populations is the resulting loss of fishing skills. Fewer people on the island are engaging in fishing and the

previous techniques are being forgotten. As opposed to the previous methods with stick and line or small nets, most of today's fishermen use large nets to more indiscriminately collect fish. If no net is available, some informants explained their use of machetes to catch fish in shallow water. Another change in fishing techniques that is a response to there being fewer fish available, but what is also perceived to be contributing to smaller catches, is the switch from traditional sailing canoes to motorboats for ocean travel. Although the motorboats make it easier to travel farther in search of fish, it is thought that the sound of the motor scares the fish away, hence reducing the catch. Either way, the traditional skills of fishing are being replaced with modern strategies as fewer fishermen catch fewer fish.

Coral reefs surrounding the island were considered to be healthier and more alive in the past. The present condition of the corals is perceived to be unhealthy and it is thought that they are overeaten by fish. It was reported that there are fewer fish out on the reef and that divers swim out there less frequently, resulting in a reduction in the number of people confident and competent enough to fish off shore on the coral reef.

Water

While the sea (*taari*) was often referred in relation to other environmental resources, two components of the ocean discussed were specific to the condition of the water. Informant responses were categorized as Waves and Water Temperature.

Although informants did not comment on the past qualities of waves (*te no*), they did perceive them to crash higher on shore than before, with multiple reports of waves washing up on land beyond the beach and over seawalls. It was mentioned that while storms caused water to reach the road in some places, it was maintained that flooding

from waves also occurred during calmer weather. There were no reactive strategies to the effects of higher waves provided by any informants. Nor were there any responses mentioned to the claims of warmer water temperature. It was said that there were more fish in the channels in the past, when the water was cooler, but that since then the fish were dying in the warmer water.

4.2.3 *Karawa* (Sky)

The informants identified environmental resources associated with the sky that were coded and organized into the categories of Seasons and Weather. Included in their responses and described here were the resources that did and did not change, along with the perceived effects of the changes and their reactions to the effects of those changes. It must be considered that the time of year these responses were gathered, the rainy season, may have had an influence on the perceptions of the informants.

Seasons

Typically, the tropical climate of equatorial Kiribati has two seasons, a wet season and a dry season. In the past, informants recognized strong six-month seasons, the wet season, *Aumeang*, from around September until about March, with the rest of the year making up the dry season, *Aumaiaki*. Nowadays informants argued that they had a hard time distinguishing the seasons. They reported irregular rain and shine, with storms occurring throughout the year. Due to quick changes in the weather, informants can't identify definite seasons in recent years and complain that without a significant dry season they struggle to complete traditional chores such as fixing their houses, which would normally be completed during *Aumaiaki*.

Weather

Discussion topics related to weather were coded into the categories of Sunshine, Rain, Air Temperature, Wind, and Storms. Each environmental resource changed in ways that both benefit and challenge the island inhabitants.

The responses provided regarding the quantity of sunshine (*te riringa*) perceived on the island was almost inconclusive. One informant stated that there was no change in the amount of sun while others claimed definite change. Some said there was less sun in the past, while others said there was less sun now. A majority of the people observed there to be more sunshine in the past but some said there was more sun now. Those who thought it to be sunnier now expressed a reluctance to work in the sun, claiming to grow weary quicker and suggesting that they were affected by the increased intensity of the sun, which was considered to be not as strong in the past. Tabulation of the responses indicates there to be less sun now than in the past, which was mostly attributed to an increase in cloud cover, but there was still a significant amount of respondents who felt that the sun was stronger even if in shorter amounts of time or in overcast conditions.

The previous conclusion, that there is less sunshine now, is consistent with the claims that there is an increased amount of rain (*te karau*). While there were three comments stating that there was more rain in the past and one comment claiming that there is less rain now, all of those comments were in reference to a specific year and a specific time of the season, but even the informants who made those comments agreed that, in general, it is rainier now than in the past. One person did feel that the amount of rain was the same now as in the past but the majority of the comments were that there was less rain in the past and that it currently rains a significant amount more than before.

There used to be longer breaks between days of rain or rain only once a month and it was common for there to be long droughts of seven to eight years but now it rains more frequently without dry spells. People say that life is better now because of the increased rain. They say that as a result of the rain the plants are more alive, claiming that it is easier to garden and attributing their claims of more coconuts, more breadfruit, more weeds, and healthier pond fish to the increased amount of rainfall. But informants also point out the negative effects of more rain on the plants, claiming less breadfruit are produced and pointing out that the excessive rain makes the ground too wet for *te maunei* to grow. The rain is said to flood young plants and prevent pollination, while also flooding roads and creating puddles. Wells become contaminated when there is a lot of rain, due to higher water levels that reach previously dry, dusty areas of the well, and people tend to rely on rain tanks and catchment systems for their drinking and cooking water during wet periods.

The most noted effect of the increased rainfall was the challenge presented when trying to dry things out, whether it is copra, clothes, firewood, or food. The rain prohibits the drying of copra because four days of continuous sunshine is needed in order to completely dry the coconut enough to be sold as copra. The rain is causing it to take longer to dry out the copra and sometimes for the copra to mold in the wet conditions. As copra is a major source of income for many islanders, they have come up with various reactions to the change in their environment. Whereas in the past people only cut copra during the dry season, the increase in rain necessitates the cutting and drying of copra during wet times while the increase in coconuts makes it a lucrative activity. Some people have responded by building *te ai ni ben* or *te auti n ni ben*, small huts or ovens for

drying coconuts. By burning husks and branches in the ovens, copra can successfully be dried in three to four days despite the rain. Some of the people who do not have drying ovens, often can not dry their copra all at once but must wait many days for enough sunny weather to successfully dry the coconuts. It is common to spread the copra out under their *buia*, or raised living platform, to air-dry while waiting for more sunshine. The copra cannot be left in bags, the typical way to store it, for too long if it is not thoroughly dried or it will mold. Even if the copra begins to mold, it can be rinsed in saltwater and set out in the sun again to dry. Clothes are hung out on a line after being washed but the rainy weather makes it difficult to get them dry. Even once they are, people often lay them out in the sunshine to prevent them from molding in the humid weather. Collecting firewood is a daily task on the island and the rain makes it difficult to find enough dry fuel for the fire needed to cook and boil water. Some people store wood and coconut husks under their *buia* but the constant need can quickly deplete any stores. Foods are difficult to dry when there is a lot of rain, too. The traditional dish, *te tuae*, is made from boiled pandanus and then dried in the sun for days. If there is not enough sun, then it must be re-boiled daily until it can be fully dried. The rain also prevents the drying of salted fish and causes molding, leaving it inedible.

The temperature of the air is considered to have changed from cooler in the past to warmer recent temperatures. Some informants report that the air is cooler now due to the increased rain and cloud cover and someone even said there was no change. Those who think it is warmer complain of getting tired from the heat and not being able to work as much. It was also said that the decrease in the number of coconut trees is an effect of the current warmer temperatures.

Despite the claims of warmer temperatures, it was also perceived to be windier (*te ang*). "*E korakora te ang*" (The wind is strong) was a common comment made as small talk amongst people on the island. Informants pointed out that now the wind came from different directions as opposed to the predictable patterns of before. Although a couple people mentioned that the wind did still come from the west, as before, they said it was infrequent and in addition to the other new wind directions. The stronger wind caused more trees and houses to fall and informants explained how they made efforts to support their houses with reinforcements. Some people even admitted to being afraid of the wind, which prevented some fishermen from journeying out into the open ocean for fear of getting blown off course and lost at sea.

The claims of increased wind action correlate with informants' observations of an increase in the amount of storms (*te buaka*) and their strength. There were less storms in the past and now they are stronger. One person contended that the storms were the same as before but that the people had lost some of the knowledge about the weather (*te borau*), hence misreporting the change in the intensity and frequency. Regardless of the actual qualities of the storms, the effects are the same. Informants shared their fears and admitted to not fishing during storms because of being afraid of being washed away. They also explained that the storms made it difficult for the weekly plane flight to arrive on the island because the plane could not land in heavy storms, in effect delaying travel and the delivery of supplies. People included in their comments that flooding was common during storms, when waves and wind combined to wash up on the shore and the deluge of rain falls on the island.

4.3 Comparisons

When compared to the scientific measurements taken, the perceived qualities of the environmental resources on Tabiteuea Maiaki are consistent with the regional trends. The general observations and predictions of higher temperatures, rising sea levels, and seasonal irregularities were also reported by the informants on the island. Some of the responses identified the exact changes predicted, while others reflected symptoms of the changes. The informants' claims of warmer water and air temperatures are consistent with the regional trends of higher temperatures, while the reduced health of the coral and the decrease in the quantity of trees can be attributed to those types of change. Although there were not any direct reports of rising sea level, the informants did describe many examples of shoreline instability, specifically an increase in the erosion and deposition of sand, which could be interpreted as an effect of a rising sea level. The informants did recognize a change in the seasonal patterns, specifically reporting there to be irregular seasons and erratic weather patterns comprised of less sunshine, more rain, more heavy wind from different directions, more storms that are stronger, and higher waves. The changes in environmental resources that could be considered consistent with the effects of seasonal irregularities are the reported healthier trees, increased amount of tree fruits, healthier pond fish, and a decrease in pond grass, all resulting from an increase in annual rainfall. The changes acknowledged by the islanders through the comparison of the past and present qualities of environmental resources, as perceived through traditional ecological knowledge, support the patterns identified in the region as the effects of climate change.

Chapter 5
Government Actions to Address Changes

5.1 Inevitable Effects of Change and Efforts to Address Them

There are various positions taken by the different countries affected by climate change. Confronted with the current developmental and environmental conditions on the islands and with the specific predictions made for the area, the government of Kiribati has accepted the impacts as inevitable and has committed to proactive policies with short-term and long-term planning, including exit strategies, in the face of present and projected climate change.

5.1.1 Present and Projected Problems on the Islands of Kiribati

The country of Kiribati, as both a Least Developed Country and a Small Island Developing State, is in a fragile position to deal with developmental and environmental issues. The small island nation is faced with many challenging changes as the country works to provide for its citizens. An increased population has created a dependence on imported goods and services, which, along with an introduced cash economy, is resulting in a loss of traditional systems. These developmental challenges, along with the environmental issues of increased urbanization, land-use mismanagement, and environmental degradation, form the present situation from which problems will continue to build.

Improved health care has decreased infant mortality and increased life expectancy, leading to growth in population size, which has significant impacts on the state of the environment and vulnerability (Republic of Kiribati 2007:10, 30). The

growing population has become dependent on imported fuels, foods, and goods. These imports have artificially raised the carrying capacity of the islands, providing a false resource security for more people than the islands' natural resources can provide. The larger population, and its dependence on imports, creates a reliance on services. Urban services in Kiribati are currently inadequate in areas such as water supply, sanitation, and waste management, where only an estimated 44% of the population has access to safe water (Sagar and Baer 2010:252; UNDPPC 2012). Across the country, limited infrastructure pose a challenge for the government to provide the necessary services (water, sewer, electricity, education, transportation, telecommunications) for its citizens.

The population is increasingly converting from the use of traditional systems of exchange to the use of a monetary system. The implementation of a cash economy is forcing islanders to convert local resources into commodities for export (copra, fish, coconut oil) and to trade their labor for wages. The development of modern industries, with more stores and less trade, is undermining the reciprocal relationships that have traditionally sustained the communities. Loss of traditions has led to a breakdown in social cohesion, which had been a major component of resilience in local communities on Pacific islands (Meehl et al. 2007). Development has affected societal changes on many small islands, such as the gradual disintegration of traditional communities, which weakens their traditional human support networks. Along with additional feedback effect of social breakdown, there is often a loss of traditional values, such as those observed in Kiribati (Meehl et al. 2007). The wellbeing of the nation's people is "reflected in the level of intact cultural values, general health, peace, and prosperity" (Republic of Kiribati 2007:10). The reported emergence of an "unacceptable level of inequality" could reflect

eroding cultural norms due to attitude change towards the values of the natural environment and subsistence livelihood in a way that tends to downgrade such values (Republic of Kiribati 2007:10).

The growing population in Kiribati is impacting the island environment through migration to the urban capital island, Tarawa, as well as consolidating outer island settlements along lagoon shores (Meehl et al. 2007). In South Tarawa, and throughout the islands, the increase of urbanization and higher density settlements drives changes to the shoreline, altering land use patterns, exacerbating factors of vulnerability, and undermining adaptation measures (Meehl et al. 2007; Republic of Kiribati 2007:12). In areas with multiple uses and new designation, there has been difficulty in enforcing land use management strategies and controls while other areas have no clear guidelines supported by legislation. Projects, such as coastal building sites and offshore construction of jetties, are not adequately controlled to avoid potential risks from coastal erosion (Republic of Kiribati 2007:26). While adept at utilizing their available resources, the inhabitants of Kiribati have always been challenged with the poor natural endowment of the islands to which environmental stress factors are now contributing to further degradation of the environment (Fitzpatrick et al. 2016:4-6; Republic of Kiribati 2007:10). Reports have been submitted regarding the deteriorating states of coastal zones, coral reefs, fisheries, ground water, ecological health and biodiversity. These challenges, along with the overexploitation of natural resources, pose a threat to the sustainability of inhabiting the islands.

Climate change and its impacts have exacerbated these developmental and environmental related challenges, and will continue to do so (Republic of Kiribati

2007:10). Researchers predict that the majority of the islands will be uninhabitable within 50 years as climate changes bring higher temperatures, rising sea level, seasonal variations, and other impacts to coastal ecosystems. These changes will make it even more difficult to sustain healthy standards of living on the islands and are legitimate concerns as the island environment becomes more vulnerable. The government of Kiribati has chosen to accept the predicted fate of the islands as inevitable and to address the concerns as a reality.

Predictions for Kiribati are that the islands will be mostly uninhabitable within 30 to 50 years, as island resources become inadequate to sustain current population levels. Given the projections for the next 50 to 100 years, the coastal assets of small islands may be at great risk and, as the natural resilience of coastal areas are reduced, the "costs" of adaptation may be expected to increase (Meehl et al. 2007). Kiribati and other low-lying areas could experience significant inundation but entire island destruction cannot be assumed as an inevitable outcome of sea-level rise as island habitability can be compromised by any of many climate change factors (Barnett and Adger 2003; Kelman et al. 2011; UNDPPC N.d.; Rudiak-Gould 2010; Webb and Kench 2010). Vulnerable sectors are: water; agriculture; sanitation and health; economic development and culture; early extreme weather warning; coastal and settlement areas; biodiversity; infrastructure; and fisheries (Republic of Kiribati 2007:31). Trend analysis for temperature data, between 1970 and 2000, indicates a higher positive trend for the maxima than the positive trend for the minima (Republic of Kiribati 2007:21). Increases in sea surface temperature will affect coral growth and make the reefs susceptible to coral bleaching, threatening the source of fish protein for many rural islanders and weakening one of the

islands' critical buffers against storm surges (Donner et al. 2005; Kelman et al. 2011:28; Meehl et al. 2007; Rudiak-Gould 2010:7; Sheppard 2003). Studies that incorporate data gathered on the islands of Kiribati since the 1970's indicate a rise in sea level of 3-4 mm/year and the trend is expected to continue (Republic of Kiribati 2007:21). The inhabitants of Kiribati may be forced from their homes by rising sea levels within the next few decades. Islanders have tried to move inland but the narrowness of the low-lying atolls means that within the next 50 years their only choice may be to leave their ancestral islands (Pacific Islands Report 2006). Anticipated land loss and degradation, due to erosion and saltwater inundation resulting from higher sea levels, threaten the sustainability of island agriculture and food security for island populations (Meehl et al. 2007:16.4). In Kiribati, models project a reduction in average rainfall and a corresponding reduction in the freshwater lenses (Burns 2000; Kelman et al. 2011:29; Republic of Kiribati 2007:21; World Bank 2000). Changing storm patterns could impact areas previously outside standard tracking areas and although storm surges have not been regularly monitored, casual observation has reported that storm surges are becoming more damaging (Republic of Kiribati 2007:21). In addition, evidence suggests other changes in the behaviors of certain fisheries, such as their seasonal run and aggregation areas, along with diminishing fish stocks (Republic of Kiribati 2007:13). Impacts of climate change on fisheries exacerbate other anthropogenic stresses. Coral reefs and other coastal ecosystems affected by climate change will impact fisheries (Graham et al. 2006). The effects of ocean acidification are expected to harm and further stress coral reefs while affecting coral islands (Kelman et al. 2011:29). As ecological niches change within the new climate regime, new species will enter new waters and fisheries will

undergo changes due to climate change (Kelman et al. 2011:29).

It is difficult for autonomous small islands to achieve an appropriate degree of sustainability and the combination of global processes interacting with local socio-economic and environmental conditions puts the long-term ability of humans to inhabit atolls at risk (Barnett and Adger 2003; Meehl et al. 2007). Small islands have legitimate concerns about their future, based on observational records, experience with current patterns and consequences of climate variability, and climate model projections (Meehl et al. 2007). Countries like Kiribati will not simply disappear, but will become more vulnerable (Rudiak-Gould 2010). The government of Kiribati recognizes signs of trouble in the tangible changes evident in the local environment and in the trends presented and predicted through scientific measurements. The nation has decided to focus on reacting and adapting to the changes rather than to attempt mitigation efforts. Former President of Kiribati, Anote Tong, summed up the government's stance when he stated: "There's very little we can do about arresting the process. We believe it's already reached a stage where it is irreversible for most countries" (Pacific Islands Report 2006).

Given the current condition of developmental and environmental issues on the islands, the people of Kiribati would be challenged by any further stresses brought on, such as climate change. The predictions made specifically for the islands of Kiribati pose great threats to the sustainability of significant populations on those islands. Considering the present situation and projected problems, the government of Kiribati has chosen to accept as reality the prediction that the islands will inevitably become uninhabitable and is reacting in anticipation of the impacts.

5.1.2 Proactive Policies Enacted by the Republic of Kiribati

Acting from a stance of acceptance, the government has enacted proactive policies that address current and future challenges within the island nation through short-term and long-term planning and management, and are experiencing results from their efforts. The Kiribati government has approved a Climate Change Adaptation Policy and Strategy with the objective that Kiribati should be mentally, physically and financially well prepared to deal with climatic events (Republic of Kiribati 2007:6). Parliament has adopted a National Development Strategy, which has recognized that climate change is posing costly risks to economic growth, and has called for the development of "participatory and cost-effective ways of minimizing and managing risk of loss from climate change-related events" (Republic of Kiribati 2007:22). In order to optimize benefits, a one-management structure, for both short-term and long-term plans, was established in the form of the Climate Change Adaptation Strategy team (CCAS team) (Republic of Kiribati 2007:23). Collaboration in implementation has resulted in the sharing of information, capacity building in adaptation planning, and cooperation between donor countries and Kiribati, and has allowed the government to identify projects that are complimentary (Republic of Kiribati 2007:23). Through the use of National Consultations and technical reports, a broad range of coping strategies has been developed and adaptation projects have been proposed to address immediate and foreseeable circumstances due to climate change.

Climate variability, climate change related hazards and risks, and impacts on the livelihood of the people are readily recognized as requiring immediate responses, even without taking into consideration their long-term impacts (Republic of Kiribati 2007:29).

With these challenges in mind, Kiribati's National Adaptation Programme of Action (NAPA), the country's short-term planning program, has been implemented through the United Nations Development Programme with the goal "to contribute to and complement a long term framework of adaptation through identifying immediate and urgent adaptation needs that are consistent with national development strategies and climate change adaptation policies and strategies" (Republic of Kiribati 2007:3). The NAPA largely relies on National Consultations to identify vulnerabilities, coping strategies, and ways for which government may assist the communities with the coping strategies (Republic of Kiribati 2007:23, 33). Using climate change projections, the NAPA works to integrate adaptation strategies into National Development planning, to form linkages with other multilateral environmental agreements, such as The Natural Disaster Act 1993, and to identify potential barriers to implementation (Republic of Kiribati 2007:21). NAPA aims to get adaptation planning integrated into the national socio-economic policy and budget in a way that is consistent with national policies and strategies and as part of operational planning (Republic of Kiribati 2007:23). Adaptation planning is a long-term commitment and while the NAPA addresses short-term goals of dealing with immediate and urgent needs, the efforts should also be consistent with long-term adaptation goals (Republic of Kiribati 2007:23).

The Kiribati Adaptation Project (KAP), the long-term element of Kiribati's adaptation strategy, is focused on reducing vulnerabilities through raising awareness of climate change, assessing and protecting water resources, and managing inundation. Adaptation responses will also address developmental and environmental related challenges as they attempt to achieve an appropriate degree of long-term sustainability

(Barnett and Adger 2003; Republic of Kiribati 2007:10). KAP has hired several international technical consultants and advisors to focus on mainstreaming and adaptation investment preparation, elaborating on the long-term basis of adaptation planning and implementation while stressing eight focal areas: integration into national planning and institutional capacity; external financial and technical assistance; population and resettlement; governance and services; freshwater resources and supply systems; coastal structures, land uses and agricultural practices; marine resources; and, survivability and self-reliance (Republic of Kiribati 2007:23, 31). In addition to the KAP, The Environmental Act 1999 is a long-term strategy used in governmental efforts to combat the effects of climate change. The Environment Act 1999 is designed to enhance the resilience of, and minimize risks to, natural and human systems. Disasters could arise from failures to manage critical components of the environment, as well as from internal and external causes, and the Act is in place as an attempt to alleviate potential vulnerabilities through appropriate management (Republic of Kiribati 2007:26).

Together these projects have had some success. Coastal management and protection has been attempted, mostly in the form of sea walls of various design and construction, although none have been entirely effective and many are in need of upgrading (Republic of Kiribati 2007:11, 12; UNDPPC 2012). Mangrove rehabilitation has been undertaken in an aim to increase natural protection against sea-level rise and storms, and to provide resources for coastal communities. In the Pacific islands, successful mangrove rehabilitation projects have been recorded from Kiribati, Northern Mariana Islands, Palau and Tonga, with failed efforts in American Samoa and Papua New Guinea (Gilman et al. 2006). The country has also been working on the

sustainability of their fresh water supply, consultations with interested parties, increasing education and awareness, and the maturation of climatic monitoring on the islands of Kiribati (UNDPPC 2012).

5.1.3 Exit Strategies Envisioned for the People of Kiribati

Careful preparation will help but combined climate change impacts have the strong possibility of making some areas uninhabitable in the present century regardless of adaptation efforts (Kelman et al. 2011; Rudiak-Gould 2010). Faced with an inevitable situation of the uninhabitability of the islands, the nation of Kiribati is envisioning and executing steps toward a feasible exit strategy for the emigration and relocation of the citizens, while keeping in mind the types of problems to expect with the movements of large populations of people.

In an attempt for "migration with dignity", the country of Kiribati is making an effort to help train up its people so they can move overseas and establish expatriate communities as contributing members in their new host countries. These efforts are aimed at benefiting the residents of Kiribati, the migrant transnational population, and the host countries (Blaire 2008). Investments are being made in training the population of Kiribati, providing more education and increasing levels of qualifications in order to provide a viable labor pool that can contribute skills and knowledge. Through the acquisition of overseas employment and residency, the working population can contribute back to the people still on the islands through the return investment of remittances to help support relatives still in Kiribati, while also working to help more family members settle overseas in newly established expatriate communities.

Populations on coral atolls are especially vulnerable and the long-term viability of some atoll states has been questioned as climatic change could potentially undermine the sovereignty of some nations (Barnett and Adger 2003; Meehl et al. 2007; Sagar and Baer 2010:253). Inhabitants on some islands may be forced to relocate to another country without a homeland to return to and as environmental refugees, migrant islanders could require special legal status in order to be self-governing (Rudiak-Gould 2010). The government of Kiribati has already accepted that relocation may be inevitable and is trying to prepare the communities for eventual migration. Research suggests that a small percentage of the population can remain on the islands but that the majority of the population will need to be relocated. The government is making inquiries into purchasing land in other countries where the people of Kiribati could then make a mass migration for relocation. Such moves have been attempted in the past, first with a resettlement scheme from the Phoenix Islands to the Solomon Islands, and also from Banaba, also known as Ocean Island, to Rabi Island in Fiji (Silverman 1971:181; Wright 1986:115-154).

Adger et al. (2003a) argue that migration is a feasible climate adaptation strategy in particular circumstances, including in the case of small islands. However, because of current inequities in labor flows, this adaptation strategy is likely to be contested and may be a limited option in many parts of the world. Although immigration opportunities are limited for people from island nations, the Tuvaluan government has already begun to negotiate with New Zealand in order to allow for slow emigration and other countries are beginning to form similar agreements (Connell 2003). The status of refugee, as islanders escape the environmental degradation from climate change impacts, could undermine

islanders' traditional pride in self-sufficiency, leading to an internalized sense of passive helplessness (Rudiak-Gould 2010:55). The Kiribati government is taking an assertive position in preparing its citizens for the transition as honorable refugees who are not dependent upon the welfare of the host nation but are contributing members in their new locations.

5.2 Call For Cooperative Action in Addressing Climate Change

As national governments attempt to address the needs of their constituents in the face of current and projected environmental changes, they seek cooperation from a global and regional community of collaborators, while including local traditional ecological knowledge in their efforts. Although environmental changes are acknowledged on these different levels, local reactions are under represented and are needed in order to develop the skills and strategies appropriate for addressing the challenges faced by affected populations.

5.2.1 Interactions between Kiribati and other International Interests

The United Nations Framework Convention on Climate Change (UNFCCC) is the main international environmental treaty on climate change, with the objective to stabilize greenhouse gas concentrations in the atmosphere. The treaty itself sets no binding limits on greenhouse gas emissions for individual countries and contains no enforcement mechanisms, instead providing a framework for negotiating specific international treaties with the aim of gaining consensus. The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body under the auspices of the United Nations,

established in 1988 at the request of member governments. The aims of the IPCC are to assess scientific information relevant to human-induced climate change, the impacts of human-induced climate change, and options for adaptation and mitigation. The IPCC produces reports that support the UNFCCC, which cover the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts, and options for adaptation and mitigation. The IPCC does not carry out its own original research, nor does it do the work of monitoring climate or related phenomena itself, but bases its assessment on the published literature. Thousands of scientists and experts contribute to writing and reviewing reports, which are then reviewed by governments, providing an internationally accepted authority on climate change (Barnett and Campbell 2010: 57-64; United Nations 2011; UNDPPC 2012).

Multiple regional cooperative efforts have been established across Oceania, involving foreign and Pacific participants (Mastrandrea and Schneider 2010:26; Republic of Kiribati 2007:iii). The Asia-Pacific Network for Global Change Research (APN), for example, is an intergovernmental network that promotes global change research in the region, increases developing country involvement, and strengthens interactions between the science community and policy makers. The Alliance of Small Island States (AOSIS), on the other hand, is a coalition of small island nations and low-lying coastal countries that share similar development challenges and concerns about the environment (Barnett and Campbell 2010:101-102). Another example, the Secretariat of the Pacific Community (SPC), is committed to helping Pacific Island countries and territories (PICTs) address risks posed by climate change and respond.

The Pacific Regional Environmental Programme (SPREP) is another inter-governmental organization supporting SIDS dealing with climate change.

Kiribati dependency on assistance from abroad for socio economic development is expected to increase as the effects of climate variability increases (Republic of Kiribati 2007:7). SIDS concerns should be of global concern, leading to global responses, while at the same time allowing SIDS to choose their own responses but with external resources and support (Kelman et al. 2011:31). External financial and technical assistance make international cooperation for adaptation possible, and facilitate capacity building in terms of resilience (Mimura et al. 2007; Republic of Kiribati 2007:30).

5.2.2 Collaboration with Cooperative Citizens of Kiribati

There is an increased appreciation, and acceptability of the validity, of traditional knowledge (Berkes 2012:3; Crocombe 1989; Fox 2003; Johannes 1989; MESD 1999; Smith and Sharp 2012; Thomas 2001:416). While some Indigenous groups request to be considered, many national and international programs proactively incorporate Indigenous values and knowledge, including the Intergovernmental Panel on Climate Change, which has increased its focus on local adaptation (Declaration at COP17; Mimura et al. 2007). The Kiribati government intends to develop a framework for addressing environmental change that is informed by climate change at a local level (Berkes 2012:16; Republic of Kiribati 2007:21). Many development programs in small islands include participation of local communities in capacity building, incorporating traditional technologies and skills used by island communities to cope with past climate variability (Eamer 2006; Kofinas et al. 2002; Mimura et al. 2007:712).

These communities have accumulated traditional ecological knowledge through generations of occupation of their lands and experiences of past events. Such locally constructed knowledge can provide key information for the monitoring of environmental change or in sustainably managing complex ecological systems (Berkes 2012:3, 47; Eamer 2006; Kofinas et al. 2002). Some traditional groups have predictive abilities for natural disasters and weather phenomena, while others are excellent observers and interpreters of change in the environment (Berkes 2012:50; Craighead 1994; Tompkins et al. 2005:87; Raygorodetsky 2011). Local-level inputs and traditional ecological knowledge have been found to be essential in understanding and integrating regional and global change while providing a foundation for community-based adaptation and mitigation actions at the international, regional, national, and local scales (Berkes 20012:48; Capistrano et al. 2005; Gadgil et al. 2000; Kelman et al. 2011:30; Raygorodetsky 2011; Reid et al. 2006).

The feasibility of integrating traditional ecological knowledge with resource management strategies and applying them to contemporary environmental problems has gradually been recognized in the international arena (Berkes 2012:3; Berkes and Folke 1998; Thomas 2001:415). While Small Island Developing States face numerous challenges and struggle with the implementation of policies that balance the goals of economic development with sustainable resource management, adaptive capacity and resilience can be strengthened through the application of traditional ecological knowledge found within their communities (Berkes 1993; Kelman et al. 2011:32; Thomas 2001:415). Some of those values and traditions are compatible with modern conservation practices, and the complementarity of local knowledge and scientific knowledge has been

increasingly recognized in resource management programs (Berkes 2009; Nurse et al. 2001). For example, in Oceania, given the scarcity of scientific data recorded in the region, local knowledge has successfully been used to substitute for, or complement, scientific research (Berkes 2012:41; Hunt 1997; Johannes 1998).

Many Pacific islanders are aware of the basic concept of climate change and its effects (Rudiak-Gould 2010). The native inhabitants see local changes on their islands and hear about global environmental changes through the schools, the media, and politics. The younger generations learn about environmental sciences in the schools, while the older generations hear about environmental changes and events through radio broadcasts or the local newspapers. On the islands of Kiribati, the community can listen to radio broadcasts of political proceedings, which discuss the national and international efforts of the government to respond to changes.

Responses to the scientific measurements and predictions of environmental changes on the islands have been diverse (Rudiak-Gould 2010). Some islanders accept the science and understand the concepts and consequences. Others accept the predictions based on the changes they observe occurring around them (Berkes 2012:32; Henson 2011:162-186; Root and Goldsmith 2011:45-47). Some islanders deny that the predictions are even possible, unable to comprehend the extent of the changes that could occur. Some islanders do not trust the science that is reported, while others find that it contradicts their local cosmology: many turn to the church for explanations of the changes and predictions (Farbotko 2005:282; Kuruppu and Liverman 2010; Lynas 2004:117; Rudiak-Gould 2010:73; Teuatabo 2002:89).

5.2.3 Contemporary Application of Traditional Knowledge

Through the NAPA, the government of Kiribati has made awareness raising a top priority. When there is an increased public awareness of climate change impacts, people can effect sustainable change within their environment. This awareness has the potential to influence individuals in how to avoid adverse effects on the environment, while a better understanding of traditional ecological knowledge, and the value of such knowledge, can aid communities in making their own decisions (Berkes 2012:50; Republic of Kiribati 2007:12).

Environmental resources are at risk and many of the communities living with these risks do not have the financial or technical capabilities to solve the problems they experience (Republic of Kiribati 2007:29). External support can lead to national-level actions that engage local communities to manage their climate change vulnerability themselves, by building skills and interest throughout affected areas (Kelman et al. 2011:31). Communities are increasingly recording their traditional ecological knowledge for local purposes leading to the development and strengthening of cultural norms and practices, as well as to the application of traditional ways to new challenges faced in response to environmental change (Berkes 2012:26; M'Lot and Manseau 2003; Oozeva et al. 2004).

One adaptation strategy implemented by the Kiribati government is to strengthen traditional agricultural systems, while at the same time diversifying those systems and building up the technical capabilities of the communities for project planning and management (Republic of Kiribati 2007:13-14, 29). As climate change impacts become more evident, management strategies need to be flexible enough to be individualized in

response to what locals experience within their own communities (Kelman et al. 2011:31). Small island inhabitants may need additional help adjusting to current and future environmental changes but that aid must be appropriate to the context of their island situations. Attempts to impose models of adaptation without review of their applicability in traditional island settings contribute to the vulnerability of small islands (Cocklin 1999; Meehl et al. 2007). Sometimes strategies are designed without proper consultation or consideration of cultural context and developed into frameworks that may be fundamentally different from Indigenous ways of thinking (Berkes 2012:16). Enhancing adaptive capacity involves more than just the identification of local options but needs to be considered within the larger social, political and economic processes and integrated with other policies and plans for sustainable development (Meehl et al. 2007; Sutherland et al. 2005).

Aside from government documents, two case studies, and a few efforts to highlight one strategy or overview the situation, there is little literature on local reactions, within a traditionally inhabited area in Kiribati, unlike those conducted in other parts of the Pacific (Aswani 1999; Barnett and Busse 2001; Blair 2008; Bridges and McClatchey 2009; Butler and Coughlan 2011; Crocombe 1987; Kelman et al. 2009; Republic of Kiribati 2007; Roncoli 2006; Winthrop 2001:208; Zubrycki 2011). There is a lacuna in the literature regarding local-level adaptation strategies. This type of information about environmental resources is needed in order to assess present and potential adaptive strategies. Assessing the possible impacts on a population requires considering environmental resource use and management patterns (Johnston 2001:146). Some of this data can be collected, by working with local communities, to recognize “high-risk”

behavior and to generate culturally appropriate strategies for reducing risk and adaptive measures (Johnston 2001:146; Sutherland et al. 2005). Based on current and predicted effects, the islands of Kiribati provide a context within which to measure and study environmental change and the resulting natural and cultural impacts and reactions.

Chapter 6
Conclusion

6.1 Significance and Broader Impact

The qualitative and quantitative data collected through this research describes the presence or absence of change in the past and present qualities of environmental resources associated with the village of Nikutoru. The gathered data allows for the conclusion that the changes in environmental resources on the island of Tabiteuea Maiaki are consistent with predictions and measurements of regional and global environmental change.

This research contributes ethnographic information about past and present qualities of environmental resources on the island of Tabiteuea Maiaki and provides data at the local level that is complementary to scientific measurements and predictions developed on much broader scales (Berkes 2012:41; Hunt 1997; Meehl et al. 2007; Johannes 1998; Raygorodetsky 2011). Such data can be used to connect traditional ecological knowledge and scientific knowledge in environmental change related decisions on the national and international levels (Berkes 2012:19; Johnson, 1992; Kelman et al. 2009; Kelman et al. 2011:30; Tompkins et al. 2005:68-70; Thomas 2001:416). Results from this project can be applied to addressing vulnerabilities through the sharing of knowledge between affected populations with local-level observations and policy makers addressing regional concerns, allowing both groups to identify areas of common concern (Kelman et al. 2011:30; Smit and Wandel 2006; UNDPPC; Weir et al. 2016).

6.2 Conclusions

This paper presented the problem of climate change that is faced by people on islands in the Pacific. It outlined the basic causes of climate change and how the limited available scientific measurements were compared to identify the changes that have occurred and to make the projections for predicted changes. The islands impacted by these changes were shown to be the home of vulnerable populations, some of whom have already reported feeling the effects of the changes in their environmental resources, which are affecting the traditions upon which they rely. The efforts made by governments and international agencies were presented, demonstrating the attempts made to enact policies and procedures that support local and global efforts to address the environmental changes and their effects. This paper provided a foundation for the inclusion and application of traditional ecological knowledge in the evaluation of environmental change and in the development of culturally appropriate and site-specific responses to the changes faced by the communities affected.

This dissertation presented the problem faced by communities of Oceania, specifically on the islands of Kiribati, and the lacuna of information in the scientific and academic literature detailing the past, present, and future trends in environmental resources. Building from a theoretical foundation in Historical Ecology and traditional ecological knowledge, and through the use of ethnographic field methods, the case study of informants from the village of Nikutoru on the island of Tabiteuea Maiaki, was presented. The study supported the idea that TEK can be used to identify changes in environmental resources and the resulting effects, data that can be used to supplement or complement other measurements. Through the case study it can be concluded that

changes in environmental resources are occurring on islands in the Pacific and that those changes are consistent with the trends and predictions for the region. This research contributed more data to support the position that environmental changes are affecting traditional systems in communities dependent upon those island resources. The information provided here presents some of the local reactions to changes and their effects, which can be supported by governments and agencies to create collaborative responses informed by local knowledge.

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GLOSSARY

Kiribati	English	Scientific
Te Aba	Island	
Te Ai ni Ben	Drying Oven	
Te Ang	Wind	
Te Ango	Verbena	*Premna serratifolia*
Aumeang	Wet Season	
Aumaiaki	Dry Season	
Te Auti n ni Ben	Drying Oven	
Te Baniaua	Milkfish	*Chanos chanos*
Te Baukin	Pumpkin	*Cucurbita pepo*
Te Ben	Coconut	
Te Bero	Fig	*Ficus tinctoria*
Te Bike	Beach/Coastline	
Te Bono	Rock Seawall	
Te Borau	Traditional Knowledge of Weather	
Te Buaka	Storm	
Bubuti	Undeniable Request	
Te Buka	Grand Devil's-Claw	*Pisonia grandis*
Te Buraroti	Yellow Alder	*Turnera ulmifolia*
Te Buti	High Tide/Rising Sea Level	
Te Bwabwai	Giant Swamp Taro	*Cyrtosperma chamissonis*
Te Bwabwaia	Papaya	*Carica papaya*
Te Bwiibwii	Shoreline Protection	
Te Ika	Fish (general)	
E korakora te ang.	The wind is strong.	
Te Kaina	Pandanus	*Pandanus tectorius*
Kanakinako	Erosion	
Te Karau	Rain	
Karawa	Sky	
Te Kawai	Road	
Te Kua	Whale	
Te Ma	Fish Trap/Weir	
Marawa	Ocean	
Te Mai	Breadfruit Tree	*Artocarpus altilis*
Te Maunei	Pond Sedge	*Cyperus laevigatus*
Te Mwaneaba	Community Meeting House	
Te Nii	Coconut Tree	*Cocos nucifera*
Te No	Waves	
Te Nuun	Noni	*Morinda citrifolia*
Te On	Green Turtle	*Chelonia mydas*
Te Riri Maunei	Sedge Skirt	
Te Riringa	Sunshine	
Te Ruku	Beach Morning Glory	*Ipomoea pes-caprae*
Taari	Sea Water	
Tarawa	Land	
Te Tongo	Mangrove	*Rhizophora stylosa*
Te Ua	Outrigger Canoe	
Te Uraura	Rusty Millipede	*Trigoniulus corallines*
Te Wai ni Kai	Protective Jetty	

LIST OF FIGURES AND TABLES

FIGURES

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APPENDIX A

Interview Questionnaire

Interview Questionnaire

1) Qualities of Environmental Resources

a) Past

i) How was the environment in the past?

(a) (*E uara te otabwanin n boong aika a tia n nako?*)

ii) Describe how the environment was before.

(a) (Kabarabara aron te otabwanin mai imwaina.)

iii) What do you remember from before?

(a) (*Tera am ururing ma ngkoa?*)

iv) What are the traditional stories?

(a) (*Tera karakinan ara katei ni kawai?*)

b) Present

i) How is the environment now?

(a) (*E uara te otabwanin ngkai?*)

ii) Describe how the environment is now.

(a) (Kabwarabwara aron te otabwanin ngkai.)

iii) What do you see?

(a) (*Tera am taratara iai?)*

iv) What do you think?

(a) (*Tera am iango iai?*)

v) What are the environmental resources?

(a) (*Tera kaubwain aon te aba?*)

2) Changes in Qualities

a) Is it the same or different?

i) (*E titebo ke e kaokoro?*)

b) Is there change?

i) *(Iai te bitaki?*)

c) What happened?

i) (*Tera e riki?*)

d) How is it?

i) (*E kanga arona?*)

3) Effects of Changes

a) How use the environment?
   i) (*E kanga kabonganan te otabwanin?*)
b) Which resources used?
   i) (*Baikara bwaai ae a kabonganaaki?)*
c) What are the signs you see in the change in weather on your island?
   i) (*Tera kanikina ae ko norii ni bitakin kanoan boong i abam?)*
d) How is the change for you?
   i) (*E uara te bitaki aei iroum?*)
e) How is life different?
   i) (*Kanga tera kaokoron te maeka?*)
f) What happened after the change?
   i) (*Tera e riki imwin te bitaki?*)

4) Reactions to Effects

a) How use the environment?
   i) (*Ko kanga ni kabongana te otabwanin?*)
b) Which resources used?
   i) (*Baikara bwaai aika a kabonganaaki?)*
c) How manage the environment?
   i) (*Kona kanga ni kawakina te otabwanin?*)
d) What do you do with it?
   i) (*Tera ae ko karaoia ma ngaia?*)
e) What are you going to do in response to changes in the weather?
   i) (*Tera ae kona karaoia ni kaitarai bibitakin kanoan boong?*)
f) What do you do differently with the resources?
   i) (*Tera te kaokoro ae ko karoia ma te kaubwain te aba?*)

APPENDIX B

Institutional Review Board Research Approval

UNIVERSITY OF MONTANA

INSTITUTIONAL REVIEW BOARD
for the Protection of Human Subjects in Research
FWA 00000078
Research & Creative Scholarship
University Hall 116
University of Montana
Missoula, MT 59812
Phone 406-243-6672 | Fax 406-243-6330

Date: December 6, 2015

To: Jaime Lynn Bach, Anthropology
Dr. Gregory Campbell, Anthropology

From: Paula A. Baker, IRB Chair and Manager

RE: IRB #264-15: "Perceptions of Environmental Change: Nikutoru, Tabiteuea Maiaki, Kiribati"

Your IRB proposal cited above has been **APPROVED** under **expedited review** by the Institutional Review Board in accordance with the Code of Federal Regulations, Part 46, section 110. Expedited approval refers to research activities that (1) present no more than minimal risk to human subjects, and (2) fit within the following category for expedited review as authorized by 45 CFR 46.110 and 21 CFR 56.110:

7. Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

Each consent form used for this project must bear the dated and signed IRB stamp. Use the PDF sent with this approval notice as a "master" from which to make copies for the subjects.

Amendments: Any changes to the originally-approved protocol, including the addition of any new research team members, must be reviewed and approved by the IRB ***before*** being made (unless extremely minor). Requests must be submitted using Form RA-110.

Unanticipated or Adverse Events: You are required to timely notify the IRB if any unanticipated or adverse events occur during the study, if you experience an increased risk to the participants, or if you have participants withdraw from the study or register complaints about the study. Use Form RA-111.

Continuation: Federal and University of Montana IRB policy requires you to file an annual Continuation Report (Form RA-109) for expedited studies. You must file the report within 30 days prior to the expiration date, which is **December 5, 2016**. *Tip: Put a reminder on your calendar now.* A study that has expired is no longer in compliance with federal or University IRB policy, and all project work must cease immediately.

Study Completion or Closure: Finally, you are also required to file a Closure Report (Form RA-109) when the study is completed or if the study is abandoned. See the directions on the form.

Please contact the IRB office with any questions at (406) 243-6672 or email irb@umontana.edu.

Form RA-108
(Rev. 11/12)

Institutional Review Board
NOV 2 4 2015
University of Montana

THE UNIVERSITY OF MONTANA-MISSOULA
Institutional Review Board (IRB)
for the Protection of Human Subjects in Research
CHECKLIST / APPLICATION

IRB Protocol No.: 264-15

At The University of Montana (UM), the Institutional Review Board (IRB) is the institutional review body responsible for oversight of all research activities involving human subjects outlined in the U.S. Department of Health and Human Services' Office of Human Research Protection and the National Institutes of Health, Inclusion of Children Policy Implementation.

Instructions: A separate application form must be submitted for each project. IRB proposals are approved for no longer than one year and must be continued annually (unless Exempt). Faculty and students may email the completed form as a Word document to IRB@umontana.edu. or submit a hardcopy to the Office of the Vice President for Research & Development, University Hall 116. Student applications must be accompanied by email authorization by the supervising faculty member or a signed hard copy. *All fields must be completed. If an item does not apply to this project, write in: n/a.*

1. Administrative Information

Project Title: Perceptions of Environmental Change: Nikutoru, Tabiteuea Maiaki, Kiribati	
Principal Investigator: Jaime Lynn Bach	UM Position: Graduate Student
Department: Anthropology	Office location: N/A
Work Phone: N/A	Cell Phone: 760-707-7200

2. Human Subjects Protection Training

(All researchers, including faculty supervisors for student projects, must have completed a self-study course on protection of human research subjects ***within the last three years*** *(http://www.umt.edu/research/complianceinfo/IRB/) and be able to supply the "Certificate(s) of Completion" upon request. If you need to add rows for more people, contact the IRB office for assistance.*

All Research Team Members (list yourself first)	**PI**	**CO-PI**	**Faculty Supervisor**	**Research Assistant**	**DATE COMPLETED Human Subjects Protection Course**
Name: Jaime Lynn Bach Email: jaimebach@q.com	☒	☐	☐	☐	04/20/15 ✓
Name: Gregory Campbell Email: gregory.campbell@mso.umt.edu	☐	☐	☒	☐	~~04/20/10~~ 11/25/15 ✓ Updated KB
Name: N/A Email: N/A	☐	☐	☐	☐	N/A
Name: N/A Email: N/A	☐	☐	☐	☐	N/A

3. Project Funding

(If federally funded, you must submit a copy of the abstract.)

Is grant application currently under review at a grant funding agency? ☐Yes *(If yes, cite sponsor on ICF if applicable)* ☒No		Has grant proposal received approval and funding? ☐Yes *(If yes, cite sponsor on ICF if applicable)* ☒No		
Agency	Grant No.	Start Date	End Date	PI on grant
N/A	N/A	N/A	N/A	N/A

For UM-IRB Use Only

IRB Determination:

*** Note to PI:** Study is approved for one year only. Use any attached IRB-approved forms (signed/dated) as "masters" when preparing copies. If continuing beyond the expiration date, a continuation report must be submitted. Notify the IRB if any significant changes or unanticipated events occur. When the study is completed, a closure report must be submitted. Failure to follow these directions constitutes non-compliance with UM policy and will have consequences.

_____ Not Human Subjects Research
_____ Approved Exempt from Review, Exemption # _____ *(see memo)*
X Approved by Expedited Review, Category # 7 *(see* ***Note to PI****)*
_____ Full IRB Determination
  _____ Approved *(see* ***Note to PI****)*
  _____ Conditional Approval *(see memo)* - IRB Chair Signature/Date: _____
    _____ Conditions Met *(see* ***Note to PI****)*
  _____ Resubmit Proposal *(see memo)*
  _____ Disapproved *(see memo)*

Risk Level: Minimal

Final Approval by IRB Chair/Coordinator: _____ Date: 12/6/2015 Expires: 12/5/2016

SUBJECT INFORMATION AND INFORMED CONSENT

Study Title: Perceptions of Environmental Change: Nikutoru, Tabiteuea Maiaki, Kiribati

Investigators:

Jaime Lynn Bach
Student Investigator
PO Box 9424
Missoula, MT 59807
(760) 707-7200

Gregory Campbell
Faculty Supervisor
Social Science 227
Missoula, MT 59807
(406) 243-2478

Special Instructions:

This consent form may contain words that are new to you. If you read any words that are not clear to you, please ask the person who gave you this form to explain them to you.

Purpose:

The purpose of this research study is to identify and describe the environmental resources on the island of Tabiteuea Maiaki in the Republic of Kiribati. You are being asked to take part in a research study because you are an adult native inhabitant of Nikutoru.

Procedures:

If you agree to take part in this research study, you will be asked to identify and describe past and the present qualities of environmental resources, changes in those qualities, effects of those changes, and any reactions to the effects. You will also be asked to identify the location of past and present environmental resources, changes in their qualities, effects of those changes, and reactions to those changes and effects.

Risks/Discomforts:

There is no anticipated discomfort for those participating in this study. Risk to participants is minimal.

Benefits:

There is no promise that you will receive any benefit from taking part in this study.

Confidentiality:

Your responses will be kept anonymous and will not be released without your consent except as required by law. If the results of this study are written in a scientific journal or presented at a scientific meeting, your name will not be used. The data will be stored in a locked file cabinet. Your signed consent form will be stored in a cabinet separate from the data.

Voluntary Participation/Withdrawal:

Your decision to take part in this research study is entirely voluntary. You may refuse to take part in or you may withdraw from the study at any time without penalty or loss of benefits to which you are normally entitled. You may leave the study for any reason.

Questions:

If you have any questions about the research now or during the study, contact:
Dr. Gregory Campbell Study Director (406) 243-2478

If you have any questions regarding your rights as a research subject, contact:
UM Institutional Review Board (IRB) (406) 243-6672.

Statement of Your Consent:

I have read the above description of this research study and I have been informed of the risks and benefits involved. My questions have been answered and I have been assured that a member of the research team will answer any future questions I may have. I voluntarily agree to take part in this study. I understand I will receive a copy of this consent form.

_____
Printed Name of Subject

_____
Subject's Signature Date

Statement of Consent to be Photographed

I understand that photographs may be taken during the study.
I consent to having my photograph taken.
I consent to use of my photograph in presentations related to this study.
I understand that if photographs are used for presentations of any kind, names or other identifying information will not be associated with them.

_____
Subject's Signature Date

The University of Montana IRB
Expiration Date 12-5-2016
Date Approved 12-6-2015
Chair: Paula A. Bohr

Te rongorongo nakon te aomata ma te beebwa ni kariaia

Atuun te Iango: Aia taratara kaain te kaawa ae Nikutoru, Tabiteuea Maiaki iaon aia ootabwanin ma kanoan boong.

Tia Riibooti

Jaime Lynn Bach
Tia Mwakuri
PO Box 9424
Missoula, MT 59807 USA
(760) 707-7200

Gregory Campell
Tia Reirei
Social Science 227
Missoula, MT 59807 USA
(406) 243-2478

Karaoia Moa

Ngkana iai taeka ae ko aki oota iai, taiaoka titirakina te aomata are e anganiko te beebwa aio bwa ea kabwarabwarai raoi nakoim.

Ibukin Tera

Karaoan te mwakuri aio bon ibukin kabwarabwaran ma kamatatan kaubwain te ootabwanin iaon Tabiteuea Maiaki. Ko riki n titirakinaki ibukin ae ngkoe kain te kaawa ae Nikutoru.

Mwakuriana

Ngkana ko anga nanom ni kan iira buakon te mwakuri aei ao are kona titirakinaki bwaai aikai:
1) Kabwarabwara bitakin bwain aon te aba ngkoa ma ngkai n am tabo ae ko mena iai.
2) Baikara bwaai aika a rootaki n bitaki aikai?
3) Iai mwakuri ni kaaitara aika a karaoaki ni kaineti ma te rootaki ae riki?

Kanganga/ Kamweengabuaka

Bon akea kanganga aika ana kona n riki nakon temanna ma temanna are e ira kanoan te mwakuri aei.

Bwaai n Tangira

Ia kabwara bure bwa bon akea boon mwiin am mwakuri imwin te riibooti aei

E raba am riibooti

Am riibooti are ko karaoia ena bon kawakinaki raoi n aki kinaaki aomatana ao enaaki kaotaki n akea am

The University of Montana IRB
Expiration Date 12-5-2016
Date Approved 12-6-2015
Chair:

kariaia tii ngkana iai te tua ni kariaia. Ena bon aki naba kaboonganaaki aram ke ni mwaneweaki n tain kaotakin am riibooti n boowii nako. Ena rokanaki raoi man kaokoroaki am riibooti nte tabo teuana ao am beebwa ni kariaia are ko tiaainaia nte tabo naba teuana.

E raoiroi karaoana ke e aki

Ea bon nakoim am baire bwa kona karaoa te mwakuri n riibooti aei ke ko aki. Ngkana koa bon taku ba ko aki kariaia ke ko bon kariaia ma koa manga buubai I nuukan te mwakuri aei ao bon akea te kanganga, ko inaomata.

Titiraki

Ngkana iai am titiraki ibukin te mwakuri n riibooti aei ao koa tarebon nakon:
Dr. Gregory Campell Tia Reirei (406) 243-2478

Ngkana iai am titiraki ibukin maurim nte mwakuri n riibooti aei ao koa tarebon nakon:
UM Institutional Review Board (IRB) (406) 243-6672

Am Taeka ni Kariaia ibukin te Mwakuri n Riibooti

Ia bon tia ni wareka te beebwa aei ao e bon bwarabwara raoi te mwakuri n riibooti aei. A bon bane n tia ni kaekaaki au titiraki, ao I ataia ae ana teimatoa n kaekaaki riki au titiraki n taai rake iroun are ea tia n mwiiokoaki. Ikai are ia aanga au kariaia n iira te mwakuri aei ao I ataa bukin ae I anganaki te beebwa ni kariaia aei.

_____
Aram

_____
Am Tiaaina Te Bong

I Kariaia te Rawe Tamnei
I ataia ena iai te rawerawe n tain te mwakuri.
I kariaia naba rawean tamneiu.
I kariaia naba kabonganan tamnei nte riibooti ni kaotaki nakoia aomata ma ana aaki kairekerekeaki aara ke rongorongo ibukin temanna ma temanna.

_____
Am Tiaaina Te Bong

The University of Montana IRB
Expiration Date 12-5-2016
Date Approved 12-6-2015
Chair: Sandra L Baker

APPENDIX C

Government of Kiribati Research Approval

GOVERNMENT OF KIRIBATI
O F F I C E O F T E B E R E T I T E N T I
P.O Box 68, Bairiki, Tarawa
Tel: (686) 21183 **Fax:** (686) 21902

File Ref: OB: 3/83 **Date:** Tuesday, 22 December 2015

Principal Immigration Officer
Ministry of Foreign Affairs & Immigration
P.O. Box 68, Bairiki
Tarawa, KIRIBATI

FILMING and RESEARCH PERMIT

This is to certify that the following person(s) have applied for a Filming and Research Permit from this office and has been duly approved effective from the registered date of this letter.

NAME	PASSPORT NUMBER
i. JAIME LYNN BACH	459062970

The above person(s) will be required to pay in cash, a Filming and Research fee in the amount of AUD$350.00 upon arrival, to the Revenue Cashier at the Ministry of Finance in Bairiki. Subsequently, the receipt must be deposited at the Office of the President in Bairiki to the Registry section.

Please accord to the above captioned person(s) the necessary assistance required in entering Kiribati borders.

Please feel free to contact the undersigned should you require further clarification or information.

Mr. Rimon Rimon
Mr. Rimon Rimon

For Secretary, Office of Te Beretitenti

APPENDIX D

Response Tables

TARAWA (LAND)	Resource	Quality	Past Qualities	Present Qualities	Changes in Qualities
Plants	Pandanus	Quantity (Trees)	More Trees (5)	Less Trees (4)	Less Trees (9)
		Health (Trees)	No Response (0)	Healthier Trees (1)	Healthier Trees (1)
	Coconut	Quantity (Trees)	More Trees (3)	Less Trees (3)	Less Trees (6)
		Quantity (Trees)	No Response (0)	Same Amount (1)	No Change (1)
		Health (Trees)	Healthier Trees (1)	No Response (0)	Less Healthy (1)
		Health (Trees)	No Response (0)	Healthier Trees (2)	Healthier Trees (2)
		Quantity (Fruits)	More Fruits (1)	Less Fruits (3)	Less Fruits (4)
		Quantity (Fruits)	Less Fruits (11)	More Fruits (9)	More Fruits (20)
	Breadfruit	Quantity (Fruits)	More Fruit (3)	Less Fruit (3)	Less Fruits (6)
		Quantity (Fruits)	No Response (0)	More Fruit (4)	More Fruits (4)
		Health (Trees)	No Response (0)	Healthier Trees (3)	Healthier Trees (3)
	Mangrove	Quantity (Trees)	More Trees (4)	Less Trees (2)	Less Trees (6)
	Taro Pits	Maintenance	Maintained Pits (2)	Unmaintained Pits (3)	Unmaintained Pits (5)
	Pond Grass	Presence	Pond Grass (3)	No Pond Grass (4)	No Pond Grass (7)
Invasive Species	Yellow Alder	Presence	No Flowers (2)	Flowers (4)	Flowers (6)
	Rusty Millipedes	Presence	No Millipedes (1)	Millipedes (4)	Millipedes (5)
	Beach Morning Glory	Presence	Less Vines (1)	More Vines (1)	More Vines (2)
Property	Property	Maintenance	Maintained (13)	Not Maintained (7)	Not Maintained (20)
		Use	Composted (3)	Not Compost (2)	Not Compost (5)
		Use	Worked Land (15)	Not Work Land (19)	Not Work Land (34)
		Use	No Response (0)	Work Land (4)	No Change (4)
Coastline	Tides	Height (Tide)	Lower Tideline (4)	Higher Tideline (6)	Higher Tides (10)
	General Shoreline	Condition	Less Erosion (4)	More Erosion (19)	More Erosion (23)
	Site #5	Condition	Less Erosion (2)	More Erosion (3)	More Erosion (5)
	Site #6	Condition	Less Erosion (2)	More Erosion (1)	More Erosion (3)
	Site #7	Condition	Less Erosion (1)	More Erosion (1)	More Erosion (2)
	Site #8	Condition	Less Erosion (3)	More Erosion (2)	More Erosion (5)
	Site #9	Condition	Less Erosion (3)	More Erosion (3)	More Erosion (6)
	Site #10	Condition	Less Erosion (3)	More Erosion (3)	More Erosion (6)
	General Shoreline	Condition	No Response (0)	Deposition (3)	Deposition (3)
	Site #11	Condition	No Deposition (7)	Deposition (4)	Deposition (11)
	Site #12	Condition	No Deposition (2)	Deposition (2)	Deposition (4)
Roads	Paths	Permanence	Impermanent (7)	Permanent (4)	Permanent (11)
	Causeway	Presence	No Causeway (6)	Causeways (3)	Causeways (9)
	Site #14	Condition	Deposition (6)	More Erosion (4)	More Erosion (10)
	Site #15	Condition	Less Erosion (1)	More Erosion (3)	More Erosion (4)
	Site #16	Condition	Less Erosion (1)	More Erosion (2)	More Erosion (3)

Table 4.1 Tabulated Responses for *Tarawa* (Land) Resources

MARAWA (SEA)	Resource	Quality	Past Qualities	Present Qualities	Changes in Qualities
Fish	Pond Fish	Quantity (Fish)	More Fish (2)	Less Fish (1)	Less Fish (3)
		Health (Fish)	No Response (0)	Healthier Fish (2)	Healthier Fish (2)
	Ocean Fish	Quantity (Fish)	More Fish (15)	Less Fish (11)	Less Fish (26)
		Quantity (Fish)	No Response (0)	Same Fish (3)	No Change (3)
		Quantity (Species)	More Species (8)	Less Species (12)	Less Species (20)
		Quantity (Species)	No Response (0)	New Species (1)	New Species (1)
		Size (Fish)	No Response (0)	Smaller Fish (3)	Smaller Fish (3)
		Location (Fish)	No Response (0)	Diferent Location (2)	Different Location (2)
	Coral	Health (Coral)	Healthier (2)	Less Healthy (2)	Less Healthy (3)
Water	Waves	Height	No response (0)	Higher Waves (5)	Higher Waves (5)
	Water Temperature	Temperature	Cooler Water (1)	Warmer Water (1)	Warmer Water (2)

Table 4.2 Tabulated Responses for *Marawa* (Sea) Resources

KARAWA (SKY)	Resource	Quality	Past Qualities	Present Qualities	Changes in Qualities
Seasons	**Seasons**	Regularity	Regular Seasons (9)	Irregular Seasons (15)	Irregular Seasons (24)
Weather	**Sunshine**	Quantity (Sun)	Less Sun (2)	More Sun (5)	More Sun (7)
		Quantity (Sun)	More Sun (8)	Less Sun (2)	Less Sun (10)
		Quantity (Sun)	No Response (0)	Same Sun (1)	No Change (1)
	Air Temperature	Temperature	Cooler (3)	Warmer (2)	Warmer (5)
		Temperature	No Response (0)	Cooler (2)	Cooler (2)
		Temperature	No Response (0)	Same Temperature (1)	No Change (1)
	Rain	Quantity (Rain)	Less Rain (10)	More Rain (21)	More Rain (31)
		Quantity (Rain)	More Rain (3)	Less Rain (1)	Less Rain (4)
		Quantity (Rain)	No Response (0)	Same Rain (1)	No Change (1)
	Wind	Quantity (Wind)	No Response (0)	More Wind (1)	More Wind (1)
		Strength (Wind)	No Response (0)	Stronger Wind (5)	Stronger Wind (5)
		Direction (Wind)	From West (5)	Different Direction (8)	Different Direction (13)
		Direction (Wind)	No Response (0)	Same Direction (2)	Same Direction (2)
	Storms	Quantity (Storms)	Less Storms (1)	More Storms (4)	More Storms (5)
		Strength (Storms)	No Response (0)	Stronger Storms (2)	Stronger Storms (2)
		Quality (Storms)	No Response (0)	Same Storms (1)	Same Storms (1)

Table 4.3 Tabulated Responses for *Karawa* (Sky) Resources

APPENDIX E

Site Coordinates

Site	Coordinates	
#01	S 001 28 47.4	E 175 04 19.4
#02	S 001 28 51.9	E 175 04 02.3
#03	S 001 28 56.3	E 175 04 04.7
#04	S 001 27 35.8	E 175 02 21.7
#05	S 001 29 27.1	E 175 04 35.8
#06	S 001 29 07.4	E 175 04 19.9
#07	S 001 28 16.5	E 175 03 01.6
#08	S 001 28 56.0	E 175 04 04.3
#09	S 001 28 55.1	E 175 04 01.8
#10	S 001 28 55.5	E 175 04 02.6
#11	S 001 28 54.2	E 175 04 00.9
#12	S 001 29 00.0	E 175 04 19.2
#13	S 001 28 17.2	E 175 02 59.6
#14	S 001 29 53.9	E 175 04 05.5
#15	S 001 27 51.0	E 175 02 59.6
#16	S 001 29 39.0	E 175 04 10.9

Table 4.4 UTM Coordinates for Identified Sites